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**Knowledge Engineering Process Steps:
NetWeaver™
Applied to
Community-Based Natural Resource Management
in Africa**

by

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Knowledge Engineering Process Steps: NetWeaver™ Applied to Community-Based Natural Resource Management in Africa

Executive Summary

By

J. Kathy Parker, Michael C. Saunders, Max W. McFadden, and Bruce J. Miller

Nature of Sustainable Development Challenges

This document serves two basic and integrated purposes that address some of the challenges to USAID to achieve its goal, sustainable development, are particularly daunting, since multiple and diverse biophysical, social, economic, institutional, political and other factors contribute directly and indirectly to its complexity. First, it focuses on the initiation of Community Based Natural Resource Management (CBNRM) in Africa as a general problem area. We used a new tool—NetWeaver™--to provide insights on the definition of variables, and the dynamics and interaction between and among these variables related to CBNRM. Second, we used it to enhance understanding of complex systems and assist management in decision-making that contributes to the successful initiation of CBNRM.

Community-Based Natural Resource Management (CBNRM)

In order to conduct a proof of concept of NetWeaver™, it was essential to select a problem area in development. Community-based Natural Resource Management (CBNRM) was one of many possible test cases. Existing knowledge of CBNRM served as the starting point for utilizing NetWeaver™ to facilitate the process of condensing, processing, filtering, organizing, categorizing, and analyzing disparate pieces of information from a variety of sources (e.g., simulation models, domain experts, tabular databases, and/or spatially referenced data) and then presenting it as a new synthesis.

What NetWeaver™ Does

NetWeaver™ is a computer-based tool used in a knowledge-engineering/artificial intelligence context. This context is one in which a “knowledge engineer” facilitates efforts to extract information from “domain” (subject matter) experts. The knowledge engineer works with domain experts in a process that elicits, organizes, programs, and represents their expert knowledge and encourages their participation in the design of the final knowledge base product. The knowledge base is a set of rules or heuristics that can be used to process data and information for the system (e.g., business environment or problem area) for which it was developed.

NetWeaver™ uses fuzzy logic to handle missing or incomplete data, to evaluate potentially competing goals (e.g., social development, economic growth, biological conservation), and to determine any given variable's membership (i.e., fuzzy set—a group of anything that cannot be precisely characterized or defined or measured) in a given class (e.g., if one of the major descriptors of old growth forests is trees that must be 180 years old, do you reject a “class” of old growth if the trees are only 179 years old? Or is the 179-year old tree a partial member of what might be old growth class when a less “crisp”, more precise qualitative definition is actually more appropriate?). This approach allows knowledge engineering to break out of the practice of using bivalent arguments (e.g., this is true or it is false, Yes/No, 180 years is “old growth”/anything younger is not) to interpret data. This capability of NetWeaver™ all but eliminates bivalent logic (i.e., True/False; Yes/No; Black/White; If we've not totally Succeeded/then we've failed). In this way, NetWeaver™, as a tool for development and humanitarian assistance can better reflect the complexity of the world and the “shades of gray” as opposed to “black and white” representations of the contexts and conditions in which that assistance takes place.

NetWeaver™ was developed as an Artificial Intelligence (AI) shell that accepts standard comments, literally as they are spoken, by domain experts. This helps us characterize what are often very imprecise linguistic concepts or mental models that humans hold. Another unique feature of NetWeaver™ is its modularity. The knowledge engineer can more easily create “digestible chunks” of modules or sub-dependency networks. This helps to keep the overarching dependency network from becoming potentially incomprehensible because of perceived complexity.

Basically, NetWeaver™ uses a transparent and participatory facilitated process to:

- ✓ represent the experts' common group understanding of a complex system;
- ✓ help him/her create, manipulate, test, and refine heuristics (i.e., decision models or the rules by which professional and indigenous experts understand and respond to a given situation or problem) that demonstrate the logical relationships between and among variables and linkages between the individual parts and the whole;
- ✓ integrate models from across disciplinary fields to better reflect the complexity of the actual management decision making context;
- ✓ provide the ability to trace the logic structure from data to conclusions;
- ✓ run and evaluate freshly elicited knowledge “real time” while the domain expert is present;
- ✓ help decision makers interpret and manipulate the output of the decision model that provides mathematically robust knowledge about complex problems and that

has been used to evaluate less than precise information (Saunders and Miller 1999).

The Process

The generic steps to using NetWeaver™ are:

- A. Knowledge Elicitation--This involves the transfer of area specific knowledge from Domain Experts to the Knowledge Engineer.
- B. Knowledge Representation--This involves the incorporation of the elicited knowledge by the Knowledge Engineer into NetWeaver™
- C. Knowledge Verification--This involves the testing and verification of how well the incorporated knowledge represents what the Domain Expert knows.

To describe and bound the problem area of CBNRM Initiation, a small working group shared documentation and developed a common frame of reference. Members of the group then scoped out an initial model and began to go through the knowledge elicitation process where the knowledge engineer worked with domain experts to develop an initial array of variables for exploration and linkage in the model. As the process unfolded, domain experts continued to refine and define the set of variables that they believed formed the basis of successful determinants of successful initiation of CBNRM activities in Africa. After considerable discussion, the group prepared a questionnaire that they sent out to a group of other experts. This resulted in an excellent pre-test exercise, from which arose a revision of the questionnaire and of the approach to contacting other experts. With these revisions made, the group solicited input from an array of respondents. The group received responses on 13 sites. With this input, the primary domain expert and the knowledge engineers went through an intensive sensitivity analysis exercise. The fourth version of the NetWeaver™ CBNRM INITIATION model resulted and is described in great detail in the text and figures that follow.

The Products

The NetWeaver™ CBNRM INITIATION Model

The primary product is the NetWeaver™ CBNRM INITIATION model that can process a set of data generated from a questionnaire completed by an expert. The model also can provide an assessment of how likely a new CBNRM project might be successful. Perhaps, of greater importance, NetWeaver™ can point out the determinants that, at the start of a given project, are the weakest and need most attention.

The Set of Questionnaires

A second product is a set of questionnaires. The set represents various iterations in a process to synthesize expert knowledge and reach consensus on what the determinants of a successful initiation of CBNRM projects are. Together, these produced the following outputs.

The Outputs—What the NetWeaver™ CBNRM Initiation Model Can tell the Manager/Decision Maker:

When the data from the 13 sites were combined and batch processed, most of the determinants showed some degree of TRUEness. However, the lower rating of economic factors had a major effect on the overall rating of CBNRM Initiation. This suggests the need to look particularly at those economic factors that show a lower degree of making a positive contribution to CBNRM initiation.

Some examples provide insight into the kind of more detailed analysis that can be done on a site-by-site basis. Two examples are provided in this report that document the NetWeaver™ process undertaken.

In the Output from Site X, we see that the CBNRM INITIATION bar is bright red and to the left of the midpoint of the chart. This model output indicates that a successful initiation is not likely. Additional information is provided by the presence of red bars for Institutional, Economic, Political, and Legal factors that all indicate as problem areas. These would have to be greatly improved upon if successful initiation is to be achieved. Thus, model output can provide the field manager or decision maker with insights about whether to re-allocate resources to certain determinants or even perhaps to not initiate the project if too many resources would be necessary to make this effort successful.

In the Output for Site Y, we see a vastly different result. Model output indicates some degrees of strength at the project site in the areas of Community Cohesiveness, Economic, Legal, Political, Institutional, and Biophysical factors. On the other hand, we see that Social factors are basically indeterminate and that the Extent of Ability to Manage is slightly negative. This means that, although most of the determinants are positive, more attention will have to be devoted to improving the extent of ability to manage and improving social factors at this site.

The model itself does not answer the “why?” question per se. But, it provides insights for managers and decision makers to discuss based on the data provided. It gives them an opportunity to explore areas where more work might be needed before they decide to initiate a project.

Knowledge Engineering Process Steps: NetWeaver™ Applied to Community-Based Natural Resource Management in Africa

By
J. Kathy Parker, Michael C. Saunders, Max W. McFadden, and Bruce J. Miller^{1,2}

Introduction

Nature of Sustainable Development Challenges

Fundamentally, development assistance givers face the dynamics of change, unfixed boundary conditions, fuzzy definitions of variables, subjective assessments, consistently irrational or different kinds of rational beliefs, and complex systems. All these heighten the level of challenge that we, as professionals, have in meeting the real needs of humans and other living and non-living things (Parker 1999).

The challenges to USAID to achieve its goal, sustainable development³, are particularly daunting, since multiple and diverse biophysical, social, economic, institutional, political and other factors contribute directly and indirectly to its complexity. For example, consider just one element of sustainable development, the environment. Direct and indirect interdependencies between agriculture, water quality and quantity, human health,

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² USAID's Africa Bureau, Office of Sustainable Development (AFR/SD) and the Office for Foreign Disaster Assistance have provided funding of Phase 1 for a proof of concept of NetWeaver™. The cooperators in this effort are The Heron Group, LLC, based in Georgetown, DE and Penn State University in University Park, PA. Other cooperators included the International Resources Group (IRG) and Associates in Rural Development (ARD). IRG had been working on an Environmental Trends Analysis for Africa for some time. Two IRG staff participated in this effort as CBNRM experts—Asif Shaikh and Bob Winterbottom. Another member of the IRG team—John Woodwell—is a modeler working with STELLA, a graphical programming language, used to develop dynamic systems models. Henri Josserand, from ARD is developing a synthesis of CBNRM case studies and lessons learned for AFR/SD and served as a primary domain expert. For the verification of this effort, the following experts provided input: Yves Prevost (World Bank) and David Gibson (Chemonics). The authors appreciate the assistance of all who participated.

³ Sustainable development at its simplest = sustainable economy + sustainable environment

forestry, and public policy, to name just a few, exist. In addition, environment also involves numerous interdependent states and processes such as erosion, siltation, loss of habitat, desertification, etc. The challenges to the U.S. Agency for International Development (USAID) and other public and private institutions working in development and humanitarian assistance include the need to understand these complex interactions, manage these challenges and at the same time, strive for sustainable development. These are indeed monumental tasks (McFadden, Parker and Saunders 1999).

This document serves two basic and integrated purposes that address some of the challenges posed above. First, it focuses on Community Based Natural Resource Management (CBNRM) in Africa as a general problem area. We used a new tool—NetWeaver™ --to provide insights on the definition of variables, and the dynamics and interaction between and among these variables related to CBNRM. Second, we used it to enhance understanding of complex systems and assist management in decision-making that contributes to the successful initiation of CBNRM.

Community-Based Natural Resource Management (CBNRM)

In order to conduct a proof of concept of NetWeaver™, it was essential to select a problem area in development. Community-based Natural Resource Management (CBNRM) was one of many possible test cases. However, again because of support from AFR/SD, yet another contractor, Associates in Rural Development, served as a natural collaborator in this effort because of analytical work being done by Henri Josserand on the topic of CBNRM.

In looking at CBNRM as a problem area, it is important to recognize that communities (very broadly defined) are the starting point for a system of natural resource management called CBNRM. They are the “focus and foundation for assessing natural resource uses, potentials, problems, trends and opportunities, and for taking action to deal with adverse practices and dynamics” (Uphoff 1998: 5). Uphoff (1998: 8) added that:

It is increasingly argued that community institutions, formal or informal, can achieve as good or better results than with state or private management... However, successful local management systems are usually not operating in isolation from other institutions and organizations, governmental or non-governmental. The record of community involvement is not uniformly good. Experience with CBNRM needs to be looked at analytically and critically.

Thus, while some encouraging examples of community involvement in sustainable natural resource management exist, many examples demonstrate how failure to enlist and integrate local people’s interests, needs, knowledge, skills, and cooperation in sustainably managing their resources result from development intervention shortcomings (Uphoff 1998).

While a considerable base of knowledge exists (e.g., indigenous experience, external expert knowledge, evaluations, case studies, geo-referenced databases), understanding of

CBNRM systems and their components (e.g., social, economic, political, biophysical) and the effects of any of a wide variety of internal and external interventions (e.g., policy change, development of infrastructure, building of human capacity) are currently, and will always be, incomplete. However, Uphoff pointed to some of the wide array of determinants of success and some of the dynamics of complex social, institutional, political, economic, and biophysical arrangements that must be in place and functioning. The challenge, therefore, is to critically analyze and evaluate experience and increase our understanding of both CBNRM systems and the effects of interventions so that CBNRM as a development activity by communities, groups, or other associations that undertake efforts in Africa can be improved.

Existing knowledge of CBNRM served as the starting point for utilizing NetWeaver™ to facilitate the process of condensing, processing, filtering, organizing, categorizing, and analyzing disparate pieces of information from a variety of sources (e.g., simulation models, domain experts, tabular databases, and/or spatially referenced data) and then presenting it as a new synthesis.

What NetWeaver™ Does

The proof of concept effort has assessed the appropriateness of and demonstrated the utility of a tool like NetWeaver™ to improve development and humanitarian assistance efforts. Like other decision support systems, NetWeaver™ is “a computerized, user-interactive system that uses data, or models, or both to generate information that will **support** (and not replace a) **decision** maker” (Benbenishty and Treistman 1998).

NetWeaver™ is a computer-based tool used in a knowledge-engineering/artificial intelligence context. This context is one in which a “knowledge engineer” facilitates efforts to extract information from “domain” (subject matter) experts. The knowledge engineer works with domain experts in a process that elicits, organizes, programs, and represents their expert knowledge and encourages their participation in the design of the final knowledge base product. The knowledge base is a set of rules or heuristics that can be used to process data and information for the system (e.g., business environment or problem area) for which it was developed.

The developers of NetWeaver™, Michael Saunders and Bruce J. Miller, believe that it is “invaluable in the development of applications that are based on rare or specialized expertise, modeling complex systems that are resistant to precise quantification, and for developing applications that not only give partial results given insufficient data but provide guidance in the relative importance of those data that are absent or incomplete” (Saunders and Miller 1999). One of NetWeaver’s™ particularly unique capabilities is that it moves beyond traditional Artificial Intelligence systems. Traditional AI systems require discrete (i.e., precise) data for rule development. The implication here is that traditional AI approaches do not allow “shades of gray” or levels of imprecision. Consequently, rules must be written for every condition. This is a laborious process, and

if a rule is missed or left out, the knowledge base will not work. Or if you do not know what a rule is, it can lead to incorrect conclusions.

NetWeaver™, however, uses fuzzy logic to handle missing or incomplete data, to evaluate potentially competing goals (e.g., social development, economic growth, biological conservation), and to determine any given variable's membership (i.e., fuzzy set—a group of anything that cannot be precisely characterized or defined or measured) in a given class (e.g., if one of the major descriptors of old growth forests is trees that must be 180 years old, do you reject a “class” of old growth if the trees are only 179 years old? Or is the 179-year old tree a partial member of what might be old growth class when a less “crisp”, more precise qualitative definition is actually more appropriate?). In other words, the fuzzy set may show some degree of TRUTHfulness as compared to some arbitrary, perhaps highly subjective rule—180 years or it's not “old growth”—when it is applied.

Most importantly, this approach allows knowledge engineering to break out of the practice of using bivalent arguments (e.g., this is true or it is false, Yes/No, 180 years is “old growth”/anything younger is not) to interpret data. Thus, one of the greatest advantages of NetWeaver™ is that it no longer is necessary to capture every kind of possible interaction in the knowledge base. Rather, it is only necessary to define the very best or the very worst scenario since all other scenario levels are indicated by their level of membership in the fuzzy set (e.g., we're 75% toward achieving our goal which is the degree of “TRUEness” in an ideal system state as defined by the domain expert). This capability of NetWeaver™ all but eliminates bivalent logic (i.e., True/False; Yes/No; Black/White; If we've not totally Succeeded/then we've failed). In this way, NetWeaver™, as a tool for development and humanitarian assistance can better reflect the complexity of the world and the “shades of gray” as opposed to “black and white” representations of the contexts and conditions in which that assistance takes place. This is consistent with Aristotle's view that: “An educated mind is satisfied with the degree of precision that the nature of the subject admits and does not seek exactness where only an approximation is possible” (cited in Sowell 1998: 6).

Saunders and Miller developed NetWeaver™ as an Artificial Intelligence (AI) shell that accepts standard comments, literally as they are spoken, by domain experts. Even the fuzzy logic module requires only minimal input by the knowledge engineer to create the fuzzy set ramp conditions (i.e., the range of the fuzzy set from fully “TRUE” values to those that are fully “FALSE”, with data values in between having various degrees of “TRUEness”). For example, a fuzzy set ramp would begin at one end with a point where less than 80 degrees Fahrenheit would be FALSE (i.e., not “hot”) for the condition of “HOT” with a slope upward to 100 degrees or higher as being totally TRUE. This would be the ramp with all the values between 80 and 100 having increasing degrees of TRUEness. The ramp would then level off to a point where everything would obviously be 100 percent TRUE. The complexity of the ramp could be modified further if there was a condition that was to be characterized as not just HOT but VERY HOT which, for example might be represented by another ramp that would show the degrees of VERY HOT from 100 degrees to let's say 212 degrees. Thus, fuzzy set ramps help us

characterize what are often very imprecise linguistic concepts or mental models that humans hold.

Another unique feature of NetWeaver™ is its modularity. The knowledge engineer can more easily create “digestible chunks” of modules or sub-dependency networks. This helps to keep the overarching dependency network from becoming potentially incomprehensible because of perceived complexity with its multiple ovals, boxes, lines and AND/OR nodes. NetWeaver's™ dependency networks not only use data effectively, they also show precisely where the information flows exist within the modular networks and also between and among them. In this manner, NetWeaver™ graphically shows how information logic flows between different boxes (data links and even between different ovals (goals).

In summary, NetWeaver™ uses a transparent and participatory facilitated process to:

- ✓ represent the experts’ common group understanding of a complex system;
- ✓ help him/her create, manipulate, test, and refine heuristics (i.e., decision models or the rules by which professional and indigenous experts understand and respond to a given situation or problem) that demonstrate the logical relationships between and among variables and linkages between the individual parts and the whole;
- ✓ integrate models from across disciplinary fields to better reflect the complexity of the actual management decision making context;
- ✓ provide the ability to trace the logic structure from data to conclusions;
- ✓ run and evaluate freshly elicited knowledge “real time” while the domain expert is present;
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The Process

The generic steps to using NetWeaver™ are:

- A. Knowledge Elicitation--This involves the transfer of area specific knowledge from Domain Experts to the Knowledge Engineer.
- B. Knowledge Representation--This involves the incorporation of the elicited knowledge by the Knowledge Engineer into NetWeaver™

- C. Knowledge Verification--This involves the testing and verification of how well the incorporated knowledge represents what the Domain Expert knows (Saunders and Miller 1999).

The following briefly describes the process (See Annex A for a list of meetings conducted to develop NetWeaver's™ CBNRM model) from this specific effort to utilize the tool—NetWeaver™—to describe and bound the problem area of CBNRM. Please note: the steps described herein are variations on multiple and diverse ways that the NetWeaver™ process might unfold under any given circumstance. However, the generic steps outlined above are clearly followed as the process unfolds (no matter how fast or slow, no matter how straight-forward or circuitous).

The following outline serves as an introduction to the steps described in more detail below:

SUMMARY OF STEPS IN THE NETWEAVER™ PROCESS TO DEVELOP THE CBNRM INITIATION MODEL

First Technical Group Meeting—"Herd Milling and Sniffing"

1. Documentation Shared
2. Common Frame of Reference
3. Discussion Between Knowledge Engineers and Domain (Subject Matter) Experts
4. Major Themes Highlighted

Second Technical Group Meeting—Knowledge Elicitation, Representation, and Preliminary Verification (Scoping and Bounding the Model)

1. Introductory Comments
2. Introduction of a Model to Work With--Scoping
3. Increased Focus in Preliminary Knowledge Elicitation Stage
4. Beginning of Questions to Direct Knowledge Representation in NetWeaver™ CBNRM Model
5. Developing Initial Array of Variables for Exploration and Linkage in the Model
6. Illustrative Example of One of the CBNRM Determinants
7. Further Bounding
8. Initial Set of Dependency Networks Developed
9. Data Links Identified
10. Iterative Process of Input
11. Initial Verification Process Begins as Elicitation Process Continues
12. "Capturing" Details to Enhance the Model

Third Technical Group Meeting—Model Verification by Additional Domain Experts

1. Use of Questionnaire in Verification of the Initial Model
2. Lack of Response to Initial Questionnaire
3. Value of a Pre-Test of the Questionnaire
4. Revised Questionnaire Re-Sent to Selected Respondents

Fourth Technical Group Meeting: Model Verification and Modification

1. Review of Database from Expert Responses to the Revised Questionnaire
 2. Model Modified Based on Sensitivity Analysis of Data and Associated Modification of Questionnaire
 3. Review by Other Members of the Technical Working Group
 4. Products During This Phase
 5. Discussion and Analysis of NetWeaver™ Output—What the NetWeaver™ CBNRM Initiation Model Can tell the Manager/Decision Maker
 6. Follow-up Steps and Products to Prepare for Next Phase
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DETAILED DESCRIPTION OF STEPS IN THE NETWEAVER™ PROCESS TO DEVELOP THE CBNRM INITIATION MODEL DURING PHASE 1

First Technical Group Meeting—“Herd Milling and Sniffing”

The formally defined Technical Group first met on May 11, 2000⁴. During this meeting, Technical Group members participated in the following activities:

1. Documentation Shared: Shared documentation of key CBNRM literature that served as a common frame of reference for the discussions focus of this meeting;
2. Common Frame of Reference: Received a one hour presentation by one domain expert (Josserand) who provided both a synthesis of the literature and noted what the literature says about many of the determinants of successful CBNRM (materials prepared for this presentation and elaborated upon later are available from Josserand);
3. Discussion: Had five hours of discussion between knowledge engineers and all domain experts present to bound the issue and begin to have a common understanding of the CBNRM problem area;

⁴ Participants included: Michael Saunders (The Heron Group, LLC), Bruce J. Miller (The Heron Group, LLC), Max W. McFadden (The Heron Group, LLC), Henri Josserand (ARD), John Woodwell (IRG), and Paul Bartel (USAID/AFR/SD).

4. Major Themes Highlighted: Received details on a major theme about both horizontal and vertical relationships that seem necessary in order for CBNRM to be successful. In other words, horizontal relationships exist at the local level—among households, among communities, among user groups, etc.—and that vertical linkages (with upward and downward interactions) exist—between various levels of organization from the local to national. An example of horizontal linkages might be the mobilization of resources to achieve more successful resource management that crosses local geographical boundaries (e.g., districts). The multidirectional interactions between levels might be illustrated by national level policy that promotes (or at a minimum tolerates) CBNRM while interests and experience may encourage local advocacy to change national level policies that promote CBNRM. In effect, the experts began to articulate one conceptual model of the various components and how the CBNRM “world” functions.

Saunders describes this initial stage of the process as “herd milling and sniffing”. It is when participants begin to get to know each other and what each brings to the table and when they begin to share preliminary information on the topic at hand.

Second Technical Group Meeting: Knowledge Elicitation, Representation, and Preliminary Verification⁵

1. Introductory Comments: One domain expert (Josserand) began to describe some of the general conditions of Africa, where: a) most people work in the primary sector; b) the primary sector, however, contributes only a small proportion to the GNP relative to other sector activities; c) productivity is conditioned by risk associated with it (e.g., tenure, climatic conditions); and d) low productivity, in great part, is due to a complex set of issues, including lack of tenurial security, low educational levels, lack of incentives, high marketing and transaction costs.

2. Introduction of a Model to Work With: A second expert (Bartel) drew a model based on and building on work done by Odum in Uganda that shows the flow of value through a general system and how it affects decisions at the household level (See Annex B).

Brief discussion (and some modifications added to the model) followed during which participants raised questions about how this model can be used to look at the efficiency of transforming inputs and outputs, how to identify points where changes in constraints must be addressed, and what the process would be to transform the system into a more sustainable one.

⁵ Participants during both days of this meeting included Michael Saunders (The Heron Group, LLC), Bruce J. Miller (The Heron Group, LLC), Max W. McFadden (The Heron Group, LLC), Henri Josserand (ARD), John Woodwell (IRG), and Paul Bartel (USAID/AFR/SD). Participants during all or part of the second day of the meeting included Mike McGahuey (USAID/AFR/SD), Asif Shaikh (IRG), and Bob Winterbottom (IRG)

Josserand went back to one of his major concerns—i.e., how to modify the policy environment for CBNRM to be implemented, such that there can be an increase in the flow of value through the system, as portrayed by the model drawn by Bartel. Questions arose about how to measure change in other factors (e.g., labor, investment, markets) that occur because of that modification of the policy environment, about whether CBNRM is the best way to leverage the general modification, and about the linkage between CBNRM and other activities (e.g., reduced deforestation).

3. Increased Focus in Preliminary Knowledge Elicitation Stage: The 1½ hour general discussion provided an opportunity for a shift to more focus attention on some potentially key points about CBNRM. The knowledge engineer (Saunders) took advantage of the moment of increased focus by beginning to ask for the kinds of questions that need to be asked, e.g. what are the metrics for positive or negative change in the policy arena—legislation modified, extent to which a country is following international conventions (e.g., signatories of conventions, taking active steps in legislation, changing bureaucratic practices)?

4. Beginning of Questions to Direct Knowledge Representation in NetWeaver™ CBNRM Model: A fundamental question began to drive the discussion. If CBNRM is effectively implemented in country X, what are the Qualities and Questions, we need to explore in the process of developing dependency networks/ causal relationships using NetWeaver™.

5. Developing Initial Array of Variables for Exploration and Linkage in Model: In response to this general question about determinants of CBNRM, the knowledge engineer began to "capture" variables and portrayed them in NetWeaver™ as a series of boxes linked to an "AND" node. [See Annex C, Figure 1a]. This represents the first version of the NetWeaver™ CBNRM Model

6. Illustrative Example of One of the CBNRM Determinants: The first issue to be raised—the level of social cohesiveness of a community—is shown in Figure 1a in Annex C. It is just one example from the array illustrated in Figure 1b. There are several features of this figure that need to be explained. The knowledge engineer created the title, "Social Cohesiveness" as a short form of identifying the general concept being portrayed in this module. He also created an "alias" which is "cohesiveness" that helps quickly key users back to this determinant when they are working with NetWeaver™. The knowledge engineer then wrote a question the domain experts posed as being critical to answer. The question the experts determined necessary to be asked is: How socially cohesive is the community? Finally, the knowledge engineer inserted a metric, identified by the domain expert, which will be used for measurement during the series of runs of the model when data begin to be obtained and input into the database created in NetWeaver™. In this particular case, the domain experts suggested that the appropriate scale for measurement ranges from 1 to 10 with 0 reflecting "no" cohesiveness, 1 being "low" cohesiveness, with degrees of cohesiveness up to 10 which reflects a "high" level.

In other words, if CBNRM is to be effective, social cohesiveness must be high—i.e., a strong causal relationship must exist between social cohesiveness and CBNRM effectiveness—as one of a diverse set of variables that contribute to CBNRM effectiveness. The domain experts emphasized that not every CBNRM activity is going to be a total success or a total failure. They added that there would be both a “critical set” as well as a “desirable set” (the necessary and sufficient) of determinants or factors and linkages that will contribute to the degree of success or failure of CBNRM.

Throughout the two days, domain experts identified topics that would reflect the conditions or qualities of effective CBNRM. The process is typically one of “splitting” or identifying individual topics among the necessary and sufficient that need to be addressed. The following is the list of topics (in alphabetical order and are identified in the software as “data links”) identified during the two-day session:

- Biophysical factors
- CBNRM Initiation
- Climatic Variability
- Cohesiveness
- Community Cohesiveness
- Distribution of benefits
- Economic Factors
- Effective Community Organizations
- Enterprise management
- Exclusion
- Extent of ability to negotiate
- Extent of ability to manage
- Infrastructure
- Labor Mobilization
- Leadership
- Leadership responsiveness
- Legal framework
- Level of Innovation
- Linkage to national policy process
- Natural Hazards
- Perceived B/C of CBNRM
- Political Factors
- Quality of Labor Pool
- Resource Quality
- Resource Scarcity
- Resource Use Patterns
- Resource manageability
- Risk of Conflict
- Social Factors
- Socioeconomic factors
- State/Community Competition
- Training

- Value of managed resources
- Vertical communication

Domain experts identified the vast majority of these topics and discussed them in some depth on day 1 of the Technical Group Meeting. On the second day, the knowledge engineer presented the topics in a Topic Dependency Outline mode (see Figure 2 in Annex 2) as well as in graphic “lumped” format, i.e., socioeconomic related topics under one oval node and biophysical under a second oval node as per Figure 2a in Annex C. This graphic representation “lumps” or modularizes all the topics listed into one Dependency Network for Successful CBNRM Determinants.

This Figure can be considered the second NetWeaver™ CBNRM Model as the work of the knowledge engineer and domain experts unfolded. In other words, it actually represents the first revision of the initial model shown in Figure 1. The oval in this figure indicates that another level of detail exists (i.e., is nested within it and can be explored further). By clicking on the oval, it is possible to see the nested details, whether another dependency network or a data link.

7. Further Bounding: One aspect of the discussion began to arise as the discussion continued at this point—the differentiation between “effectiveness” of CBNRM and “success”. This part of the discussion was not totally resolved by the end of the second day.

Another aspect of the discussion was the differentiation of what it takes for CBNRM at start-up or “initiation” as compared to when CBNRM activities become more “mature”, during implementation and then hopefully at a stage where they then achieve some possibility of sustainability. Some determinants may be absolutely critical at the start-up/initiation phase (e.g., community cohesion); others more critical at other stages like maturation or expansion (e.g., access to new technologies; resources); others more critical to spread or sustainability of the CBNRM effort (e.g., political and institutional support). However, some of these determinants may be critical at all phases, but they may require different degrees of importance at different stages in the process. The discussions by the end of the second day stopped at elaborating on aspects related to initiation of CBNRM. Due to lack of time, participants agreed to develop the concepts further to reflect the continuum of change at a future meeting.

8. Initial Set of Dependency Networks Developed: By the end of the second day, the knowledge engineer and domain experts had developed a set of dependency networks or causal relationships. First, when NetWeaver™ opens for a given model, it shows the Topic Outline (see Figure 2 in Annex C). If you then click on the individual triangles on this outline, you will begin to see the dependency networks in graphic form with circle (AND or OR nodes), ovals, and boxes (see Figures 2a-2h in Annex C). The Knowledge Engineer also elaborated with the domain experts a set of questions for all the data links in each of the networks.

These “dependency networks” are typically used to graphically depict logical relationships between data and conclusion, and hence provide very useful shorthand for representing the heuristics (rules) of a domain expert during the knowledge elicitation process. In this approach, the goal (i.e., the conclusion) is reached by following paths leading from observations (i.e. data) through the logical connectors between and among those observations. The logical connectors typically consist of “AND” and “OR” nodes. In order to proceed, no path to an “AND” node can be false. Only one path to an “OR” node, at least partially, must be true. Dependency networks can be nested within one another so that the conclusion reached in one or more networks can be used as input to another, higher level network” (Saunders and Miller 1999).

The “AND” and “OR” node relationships are illustrated in the Figures that follow, but that perhaps is best demonstrated in Annex C, Figure 2h where biophysical factors have been grouped as having some “AND” relationships as well as set of “OR” relationships.

The oval shapes provide the name of a dependency network in a top-down approach to knowledge base development. The boxes (e.g., in Figure 2d, Annex C) identify data links and contain the appropriate argument (e.g., if “leadership” is ranked 10 on the scale, AND “leadership responsiveness” is ranked 10 AND “community cohesiveness” is ranked 10, THEN the conditions for cohesiveness have been met 100%) for the logical relationship articulated by the domain expert.

The “nestedness” of dependency networks is illustrated by looking at Figure 2c in Annex C.

9. Data Links Identified: As the knowledge engineer went through the process of working with domain experts to identify dependency networks/causal relationships, he also began to “capture” their knowledge about appropriate data to measure. As noted above, these are depicted in the boxes in Figures 2b-2h.

10. Iterative Process of Input: At an early point, participants discussed issues related to effectiveness of resource management (see Annex D1, the Questionnaire for more detailed definitional and description of its meaning). Participants then discussed the need to differentiate between management of the resource and effectiveness of management of the income generating enterprise. The intent was to differentiate between management of the biophysical resource as compared to management of the enterprise. See Figure 2h in Annex C under Biophysical Resources and Figure 2f under Economic Resources in Annex C.

Members of the Technical Working Group did not address the latter issue immediately. They only added it to the list of questions later as the process moved toward refinements of the first set of questions. This process of developing and refining questions became the focus of the next steps in the process.

11. Initial Verification Process Begins as Elicitation Process Continues: The Technical Group was able to go through each of the dependency networks except for the biophysical factors before the end of the 2-day working session. Work needed to be completed on those details before moving to the next activity of identifying indicators. It is important to note that this part of the process is fundamentally one of “verification as you go”. The group of experts worked out details so that they could reach agreement on every determinant listed, question asked, and general description made. The object-oriented nature of the software creates the cross links. Thus, in 1½ day, a group of domain experts essentially built and initially verified the second NetWeaver™ model that focused only on CBNRM Initiation.

12. “Capturing” Details to Enhance the Model: Additionally, following the May 31-June 1 meeting, it was essential to document elements of the model in addition to posing the questions associated with the acquisition of data values. These must be “captured” and documented as part of the process, and they can be input at the earliest possible time as the process continues to unfold. Josserand worked with the initial output of NetWeaver™ to provide definitions, descriptions and comments. Additional substantive information needed to be added in the form of:

- b. Explanations
- c. Assumptions
- d. Domain sources
- e. Citations
- f. Comments (for dependency networks)

Saunders and Miller will continue insert this information into NetWeaver’s™ Topic Documentation dialog boxes (See illustrative example in Figure 3, Annex C. Also, refer to the full set of questions and descriptions in Annex D1), as it becomes available from the domain experts. This information will serve as reference and explanatory material for discussions and challenges to the model.

Third Technical Group Meeting: Model Verification by Additional Domain Experts⁶

1. Use of a Questionnaire to Assist in Verification of the Initial Model: The next Technical Group meeting followed on July 12-13 with external reviewers participating in the Knowledge Verification phase⁷. As further input, the Technical Group sent out a questionnaire (See Annex D1) to a select group of CBNRM experts working on projects in the field. The Technical Group asked that these experts rate their projects on the scales provided in the data links boxes.

2. Lack of Response to Initial Questionnaire: This meeting proved premature since only 1 expert responded to the questionnaire. This suggested the need for a concerted effort to work with respondents to obtain input. It also suggested a need to provide a

⁶ Participants included: two experts to help in the Verification Process—David Gibson, Chemonics International and Yves Prevost, World Bank. Other participants included: Bartel, McGahuey, Josserand, Woodwell, Saunders, Miller, McFadden and Parker

clear statement in the request for responses about the potential return on the investment (of time, thought, etc.) to the respondent for participating in the questionnaire response process. In other words, we need to give respondents a “what’s in it for me” incentive up front.

A related issue arose. It concerns how much and what kind of information about what NetWeaver™ needs to be disseminated to questionnaire respondents before they complete the questionnaire. The Technical Group decided that providing too much information would continue to distract from the need to get responses to the questionnaire rather than trying to figure out what the model was without benefit of having a fuller demonstration and/or explanation. In fact, some of the experts who were contacted constructively challenged the questionnaire but did not fill in the questionnaire. Clearly, the questionnaire needed more work done on it. Admittedly, working with experts via a questionnaire instead of face-to-face is not the typical NetWeaver™ facilitated approach. However, it seemed the only means given resources and time to obtain additional input and verification of the model.

3. Value of a Pre-Test of the Questionnaire: Josserand worked with colleagues at Associates in Rural Development (ARD) to complete the questionnaire. They provided thoughtful and useful input that served as a reminder of the value of a pre-test of any questionnaire. The information obtained from this effort served as the basis for further refinement of the questionnaire in terms of both the characterizations of the determinants that had been identified in earlier phases of the process and in terms of the formatting of the questionnaire to make responses easier to provide. The ARD group also raised questions about who the audience for this effort is—project designers, field personnel managing CBNRM projects, higher level managers allocating resources, evaluators, etc.
4. Revised Questionnaire Re-Sent to Selected Respondents: After the Technical Working Group reviewed, refined and edited the questionnaire to remove inconsistencies, redundancies and terminology that was not immediately clear, they sent out the questionnaire, along with a revised set of instructions to selected experts. The experts were asked to send the completed questionnaire to one of the Knowledge Engineers. The Technical Working Group received 13 completed questionnaires.

Fourth Technical Group Meeting: Model Verification by Additional Domain Experts⁸

1. Review of Database from the Expert Responses to the Questionnaire: The Technical Working Group had been scheduled to meet for two days—May 8-9, 2000 to go over the responses to the revised questionnaire. However, the Knowledge Engineers (Saunders and Miller) asked for a 4-hour period to meet with the primary expert (Josserand) to review the model using the responses that had been set up in a database format.

⁸ Participants on day one were: Saunders, Miller, McFadden, and Josserand. Participants on day two were: Bartel, McGahuey, Parker, Woodwell, Saunders, Miller, and McFadden

2. Model Modified Based on Analysis of Data: This day proved to be a very significant meeting. As the Knowledge Engineers loaded data for several different CBNRM sites, it was easy to see that the initial model results did not agree with overall assessment values of success provided by experts who responded to the questionnaire. Both the Knowledge Engineers and the primary domain expert questioned the results and discussed the possible reasons why the model was not performing better. The best answer seemed to indicate that there might be too much redundancy and overlap in the questions themselves and how they were configured in the model.

Subsequently, the Knowledge Engineers lead the primary domain expert through each of the major components of the model—economic, social, political, and biophysical. Beginning with economics, the group analyzed each question for overlap in meaning. If it could not stand by itself, the group eliminated it. In some instances, questions were determined not to belong where they had been placed originally and were moved to another area (e.g., from social to political). Again, if the group identified any overlap in meaning or lack of fit, they deleted it. In each major area, the Knowledge Engineers and the Domain Expert next looked at importance and set up secondary “OR” situations that would allow the model to accept secondary pathways if primary pathways were not strongly “TRUE”. The NetWeaver™ CBNRM Model 4 Topic Outline appears in Figure 4 in Annex C. The new dependency network and data links appear in Figures 4a-4i. For comparison of difference between one model without data and one with input from other domain experts, refer to Figure 2h and Figure 4i.

After the group completed this procedure, they ran the data for several locations again. This time the model output was considerably different, and it more closely represented what the expert knew about these locations (See Figures 5, 5a and 5b). Additionally, when compared with the overall values submitted in the questionnaires by the respondents, they were either in strong agreement or only slightly off, reflecting the subjective nature of the rating itself.

In the Topic Outline, you can double click on CBNRM Initiation, go to the menu bar and drag down Data to link data in NetWeaver’s database. Click on ALIAS and from the database open the ALIAS icon; click on INPUT and open the CBNRM4 icon; click on OUTPUT and click on the OUTPUT icon. Then batch process to ensure that data for all 13 sites are processed. Then on the diagram, as per Figure 5, you will see the results. The increasingly brighter green indicates more TRUEness or a higher rating on the scale; the increasingly brighter red indicates stronger negativity, or a lower rating on the scale.

3. Review by Other Members of the Technical Working Group: On day two of the meeting the smaller group presented the revised dependency networks and discussed the output of the model relative to its new form, the modifications the smaller group had made, and any reflections they had on given CBNRM sites with which they were familiar.

The Products

1. Products During this Phase:

While a write-up of the NetWeaver™ model development process, such as this document helps users understand the complexity of the process, it is equally important not to lose sight of the other products of the process to date.

The primary product is the NetWeaver™ CBNRM INITIATION model that can process a set of data generated from a questionnaire completed by an expert. The model also can provide an assessment of how likely a new CBNRM project might be successful. Perhaps, of greater importance, NetWeaver™ can point out the precise determinants that, at the start of a given project, are the weakest and need most attention.

A second product is a set of questionnaires (see Annexes D1 and D2). The set represents various iterations in a process to synthesize of expert knowledge and reach consensus on what the determinants of a successful initiation of CBNRM projects are. While questionnaire D2 can be distributed in hard copy form, it is internalized in the NetWeaver™ CBNRM INITIATION model.

Together, these produced the following outputs.

2. Discussion and Analysis of NetWeaver™ Output—What the NetWeaver™ CBNRM Initiation Model Can tell the Manager/Decision Maker: When the data from the 13 sites were combined and batch processed (see Figure 5), most of the determinants showed some degree of TRUEness (i.e., they were rated overall as being higher on the scale, thus they are brighter green and further to the right on the scale). However, the lower rating of economic factors had a major effect on the overall rating of CBNRM Initiation. This suggests the need to look particularly at those economic factors that show a lower degree of making a positive contribution to CBNRM initiation.

Some examples provide insight into the kind of more detailed analysis that can be done on a site-by-site basis. Two examples are provided in this report that documents the NetWeaver™ process undertaken during phase 1.

In the Output from Site X (See Figure 5a), we see that the CBNRM INITIATION bar is bright red and to the left of the midpoint of the chart. This model output indicates that a successful initiation is not likely. Additional information is provided by the presence of red bars for Institutional, Economic, Political, and Legal factors that all indicate problem areas. These would have to be greatly improved upon if successful initiation is to be achieved. This model output can provide the field manager or decision maker with insights about whether to re-allocate resources to certain determinants or even perhaps to not initiate the project if too many resources would be necessary to make this effort successful.

In the Output for Site Y (see Figure 5b), we see a vastly different result. On the one hand, in this case, we see six green bars going to the right on this scale from –1 to 0 to +1. These green bars indicate that the respondent believed that the project site had some degrees of strength that would contribute to successful CBNRM INITIATION. More specifically, for the other factors shown, the respondent provided input via his/her ratings on the scale from 1-10 for each determinant identified in the questionnaire. Based on this input, NetWeaver™ generated the following model output which includes both the numbers recorded on the 1-10 scale as well as converting this input into % TRUE (degrees of truthfulness) or % FALSE: Community Cohesiveness at 60% TRUE (respondent rated it as 8 on scale of 1-10), Economic factors at 54% TRUE (arrived at by the respondent recording a 9 or 80% TRUE for Perceived Benefit/Cost of CBNRM; 8 or 60% TRUE for Distribution of Benefits, and 7 or 40% TRUE for both Infrastructure and Financial resources), Legal factors at 47% TRUE, Political factors at 42.4% TRUE, Institutional factors at 40% TRUE, and Biophysical factors at 40% TRUE. On the other hand, we see that the respondent rating, as processed through NetWeaver™, indicated that Social factors were almost indeterminate (.04% FALSE which is why the bar looks like it is on 0) and the Extent of Ability to Manage was slightly negative (16% FALSE). In the model itself, it is possible to trace the problem areas through the dependency network and to determine more precisely which determinants were contributing to the slightly positive analysis of this particular CBNRM activity at initiation. For example, while the model indicated that the Legal Framework rated very low (i.e., 20% FALSE) for this site at initiation, Security of Tenure was high (60% TRUE) and Authority of Communities was moderate (40% TRUE). This helps explain why the NetWeaver™ model rating of Legal factors was at 47% TRUE. Thus, the interactions between and among these positive, neutral, and negative factors have contributed to a CBNRM INITIATION bar that is only slightly to the right and black (or 17.02% TRUE). This indicates that it is only slightly positive. It also means that, although most of the determinants are positive, more attention will have to be devoted to improving extent of ability to manage and improving social factors at this site.

The model itself does not answer the “why?” question per se. But, it provides insights for managers and decision makers to discuss based on the data provided. It gives them an opportunity to explore the areas where more work might be needed before they decide to initiate a project. Figure 5b has much more detailed information that identifies these areas.

3. Follow-up Steps: Upon presentation of these findings, members of the Technical Working Group have undertaken and will undertake the following:

- a. Revised the questionnaire, its wording and format
- b. Revise the model by including the descriptions, assumptions, citations, etc. of each question—to the extent feasible—in the topic documentation section of the model.
- c. Analyze use of questionnaire as an instrument for use by domain experts to provide input into the knowledge engineering process.

- d. Refined model output so it is more easily understood in terms of individual determinant effect on larger groupings and overall CBNRM success in the initiation phase.
- e. Respond to those who have raised the question about “who” the end-users of this kind of model and its various products might be.
- f. Field-tested the CBNRM INITIATION model in Zambia and perhaps field-test other countries.
- g. Further develop the model to include determinants for successful CBNRM Implementation and determinants for Sustainability

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ANNEX A: MEETING SCHEDULE

October 12-13, 1999

Environmental Information System (EIS) Partner Meetings

October 12 at WRI

- Brief presentations by all collaborators in EIS to review various tools and approaches and how they can address specific questions (included Texas A&M, WRI, University of Virginia, World Bank, Associates in Rural Development CBNRM effort, USGS, Heron Group, AFR/SD)

October 13 at USAID/AFR/SD

- Presentation on FRAME, NRM Tracker and Environmental Trends Analysis (ETA) effort

December 21, 1999

First meeting of all potential Collaborators on Environmental Trends Analysis at IRG, (plus WRI, Winrock and some additional USAID staff)

- Debriefing on NetWeaver and some other software
- Debriefing on Environmental Trends Analysis work to date
- Debriefing on efforts by other EIS partners
- Brief discussions on possible topics for proof of concept for NetWeaver™

March 15, 2000

Meeting at IRG

- Presentation of STELLA model
- Discussion about moving forward with CBNRM as primary focus of proof of Concept
- Develop list of follow-up activities before FRAME meeting

April 19, 2000

Conference call meeting

- Set meetings for late May for “Consultative Group” for ETA
- Technical Group established

May 11, 2000

Meeting at IRG

- First meeting of Technical Group
- Presentation on CBNRM by Josserand
- Discussion of how Technical Group would proceed with work effort on STELLA and NetWeaver™
- Consultative Group meeting postponed and second Technical Group Meeting proposed for late May, early June.

May 31-June 1, 2000

Meeting at IRG

- Begin with discussion of STELLA
- Start work on development of NetWeaver™ knowledge base for CBNRM
- Continue discussion of development of STELLA
- Continue development of NetWeaver™ knowledge base
- Develop follow-up steps to prepare for Verification of NetWeaver™ knowledge base in July

July 12-13, 2000

Meeting at AFR/SD

- Begin to look at data from one respondent to the questionnaire
- Work with two experts brought in to look at model—David Gibson, Chemonics International and Yves Prevost, World Bank
- Determine strategy to revise the questionnaire and obtain more input from other experts—this strategy was followed before the August 8-9 meetings

August 8-9, 2000

August 8, 2000

- McFadden, Saunders, Miller, and Josserand work with the set of questionnaires submitted
- Undertook a sensitivity analysis of findings
- Revised the model based on discussions of findings

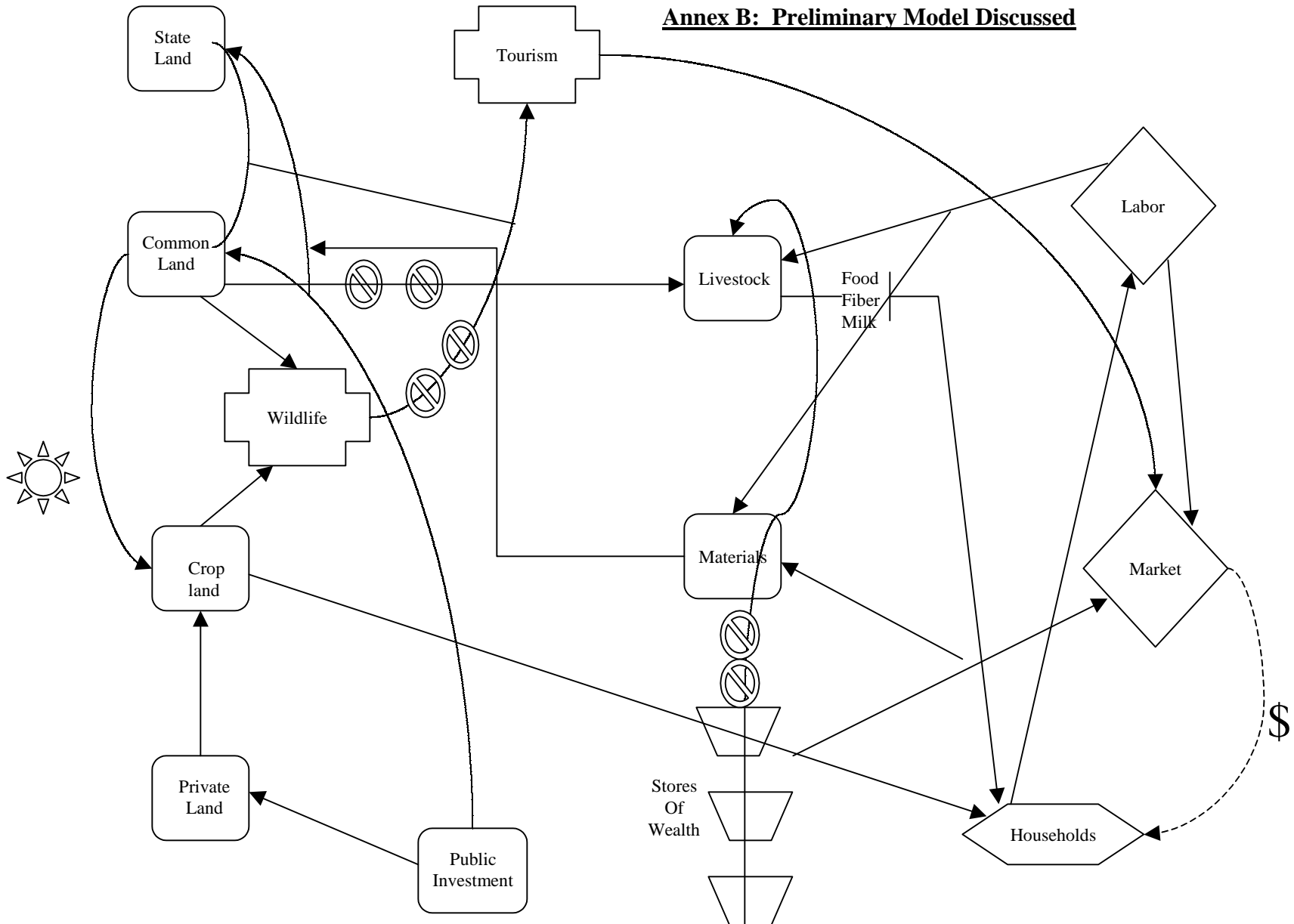
August 9, 2000

- Brief presentation made to Bartel, McGahuey, Parker and Woodwell, with Saunders, Miller, McFadden, and Josserand in attendance
- Subsequent to this meeting, the set of explanations for the questionnaire were further revised by Josserand
- Saunders input these revisions into the CBNRM version 4.1

September 12, 2000

- Attended USAID-Hosted Presentations on "Analytical and Management Tools for Natural Resources in Africa"
- Presentation of NetWeaver™ CBNRM model by Parker, Saunders, and Miller
- Participation in discussions on NetWeaver™ and other tools and background information

Annex B: Preliminary Model Discussed



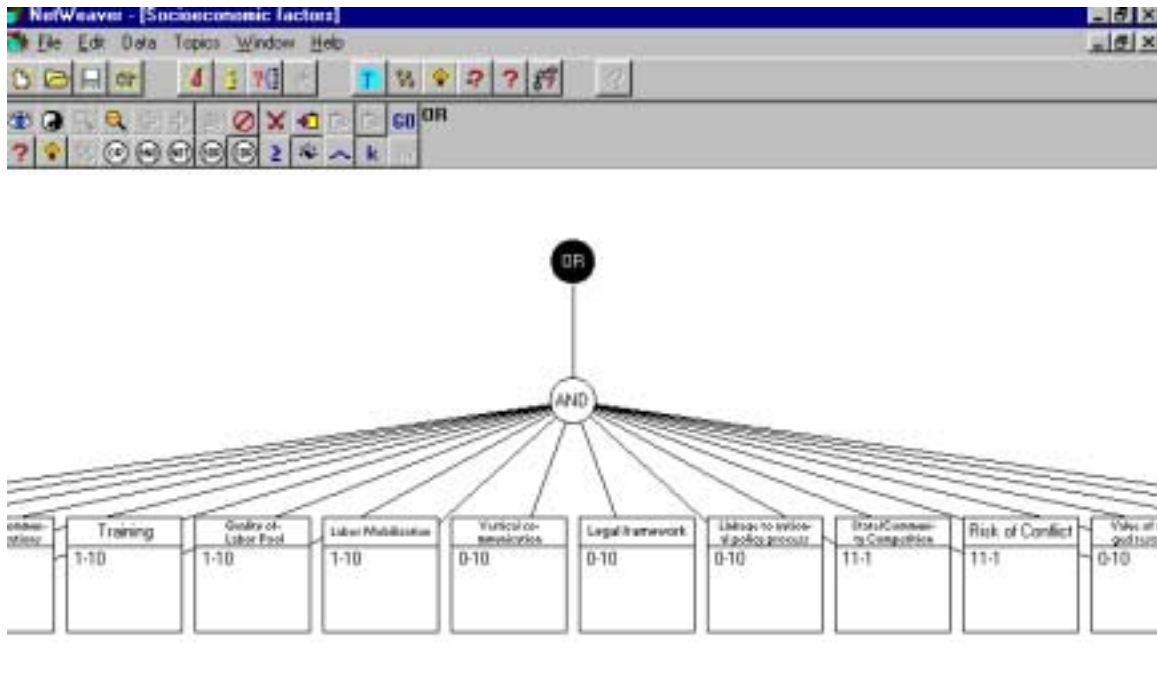
Annex C

Figures from NetWeaver™ CBNRM Initiation Models

(Screen Captures)

FIGURES

**Figure 1a: First Version of NetWeaver™ CBNRM Model
Illustrative Dependency Network
With Selected Array of Initial Socioeconomic CBNRM Determinants**



[Note: This merely demonstrates the array of Socioeconomic Factors as they first looked before they were further “lumped” as per Figure 2]

**Figure 1b: Example of One NetWeaver™ CBNRM Determinant
In Socioeconomic Factors Dependency Network of Model 1**

Community Cohesiveness

How socially cohesive is the community? 1 = low, 10 = High

Created: Wed May 31 10:40:00 2000
Last Modified: Mon Jun 05 14:51:38 2000

Alias: COMMUNITY_

Community Cohesiveness is compared in the following ways:

0-10 (0 : false) (10 : true)

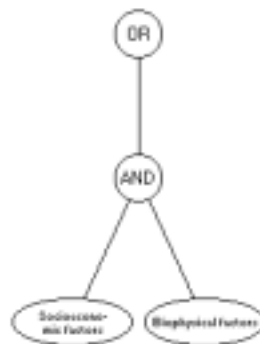
**Figure 2: Second Version of NetWeaver™ CBNRM Model:
Topic Dependency Outline
of Successful CBNRM Determinants,
Disaggregated by Key Factors, and Associated Data Links**

- Successful CBNRM
 - ▼ CBNRM Initiation
 - ▼ Socioeconomic factors
 - ▼ Social Factors
 - Extent of ability to negotiate
 - ▼ Cohesiveness
 - Leadership
 - Leadership responsiveness
 - Community Cohesiveness
 - ▼ Extent of ability to manage
 - Exclusion
 - Effective Community Organizations
 - Training
 - Quality of Labor Pool
 - Labor Mobilization
 - ▼ Economic Factors
 - Value of managed resources
 - Distribution of benefits
 - Enterprise management
 - Level of Innovation
 - Infrastructure
 - Perceived B/C of CBNRM
 - ▼ Political Factors
 - Vertical communication
 - Legal framework
 - Linkage to national policy process
 - State/Community Competition
 - Risk of Conflict
 - ▼ Biophysical factors
 - Resource Use Patterns
 - Resource manageability
 - Resource Quality
 - Resource Scarcity
 - Climatic Variability
 - Natural Hazards

[NOTE: When you first open a NetWeaver™ model, it provides you with the opportunity to see a full list of the factors that are in the dependency network. This topic dependency outline illustrates the first screen. When you click on the first circle, i.e., Successful CBNRM, it opens further to show the next level in the outline, i.e., CBNRM Initiation. When you click once on each of the triangles, you go deeper into the other levels and data links of the model. If you click twice on any of these, you begin to see graphic representations of the modules within the dependency network in Figure 2a as depicted in figures 2b-2h)

**Figure 2a: Second Version of NetWeaver™ CBNRM Model:
CBNRM Initiation Determinants Dependency Network**

Alias: CBNRM_INIT



[NOTE: If you click on the Socioeconomic Factors oval, you go down into the nesting of sub-networks as per figure 2b-2g below.]

Figure 2b: Socioeconomic Factors Dependency Network

Alias: SOCIOECONO



[Note: In NetWeaver™, if you click on the Socioeconomic Factors Oval, it will take you to the next set of ovals that further describe CBNRM Initiation determinants. The questions for these are nested under the other dependency networks that are illustrated below.]

Figure 2c: Social Factors Data Link and Links to Other Determinants

Alias: SOCIAL_FAC

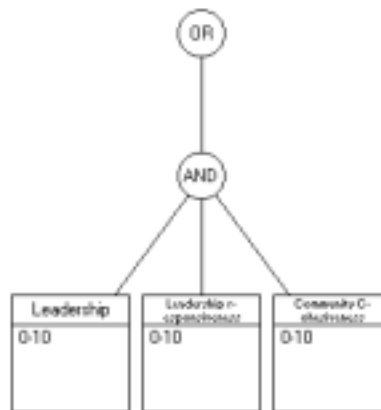


The respective questions for each of these data link and links to other determinants that have data links (already identified elsewhere) follow:

- *Extent of Ability to Negotiate*: How able is the community to negotiate joint resource use and benefits with other communities and stakeholders?
- *Cohesiveness*: (see below)
- *Extent of Ability to Manage*: (see below)

Figure 2d: Cohesiveness Data Links

Alias: COHESIVENE



The respective questions for each of these data links follow:

- *Leadership*: To what degree is there a consensus in the community as to who is their leader?
- *Leadership Responsiveness*: To what degree is community leadership responsive to the needs of community members?
- *Social Cohesiveness*: How socially cohesive is the community?

Figure 2e: Extent of Ability to Manage Data Links

Alias: EXTENT_OF2



The respective questions for each of these data links follow:

- *Exclusion*: Is a significant share of community members prohibited from participating in activities associated with resource management?
- *Effective Community Organizations*: To what extent does the community have effective community based organizations?
- *Training*: To what extent has the community benefited from training relevant to CBNRM?
- *Quality of Labor Pool*: Is this community physically able to undertake a CBNRM program?
- *Labor Mobilization*: The degree to which labor can be mobilized at the time it's needed for CBNRM activities?

Figure 2f: Economic Factors Data Links

Alias: ECONOMIC_F



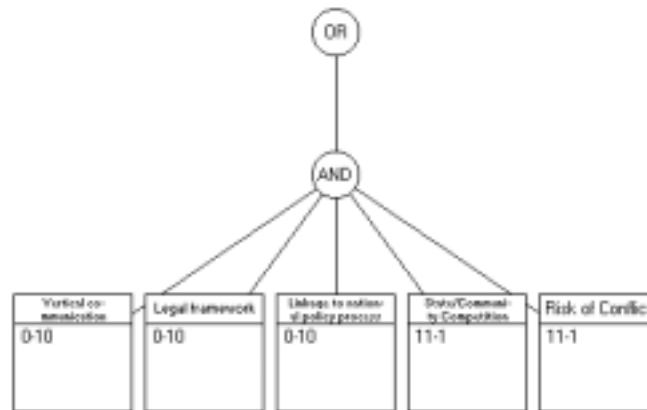
The respective questions for each of these data links follow:

- *Value of Managed Resources*: To what extent is the value of the resource(s) worth the investment of management?
- *Distribution of benefits*: To what extent can the benefits of CBNRM be distributed acceptably among the various stakeholders?
- *Enterprise Management*: To what extent can the community efficiently and responsibly manage the benefits from the enterprise?
- *Level of Innovation*: To what extent do local communities display a willingness to innovate?
- *Infrastructure*: To what degree does the infrastructure enhance the capture of the value of the resources?
- *Perceived B/C of CBNRM*: To what extent do community members perceive that CBNRM will bring more to them than it costs?

[NOTE: In this case, the completed dependency network considers all of the above as necessary and sufficient determinants of Economic Factors for CBNRM initiation.]

Figure 2g: Political Factors Data Link

Alias: POLITICAL_



The respective questions for each of these data links follow:

- *Vertical Communication:* To what extent do the community's decisions inform national authorities about the management of local resources and vice versa?
- *Legal Framework:* To what extent are community based resource management decisions within the legal framework of accepted bounds of national policy or tolerance?
- *Linkage to National Policy Process:* To what extent can the CBNRM effort be linked to various stages of the national policy process?
- *State/Community Competition:* To what extent will the implementation of CBNRM compete with other interests?
- *Risk of Conflict:* To what extent does the Rule of Law and good governance prevail throughout the country?

Figure 2h: Biophysical Factors Data Links



The respective questions for each of these data links follow:

- *Resource Use Patterns*: At the point of intervention of CBNRM, the degree to which the resource use patterns are ecologically sustainable?
- *Resource Manageability*: What is the extent to which the resource(s) lends itself to management by the community?
- *Climatic Variability*: To what extent does climatological risk induce community resource use to be diversified?
- *Natural Hazards*: To what degree are natural hazards affecting the viability of local communities?
- *Resource Quality*: Degree to which the quality of the resource(s) meets or generates a marketable demand?
- *Resource Scarcity*: Degree to which the abundance of a resource meets local demand?

Figure 3: Topic Documentation Dialog Box as Represented in NetWeaver™ CBNRM Model 3

Topic Documentation [X]

Name: Community Cohesiveness

Alias: COMMUNITY_

Hyper Link: Created: Fri Jul 07 10:24:03 2000
Last Mod: Fri Jul 07 10:24:03 2000

Comment:

Explanation: Cohesiveness is one of the critical determinants of success for a CBNRM activity. CBNRM requires

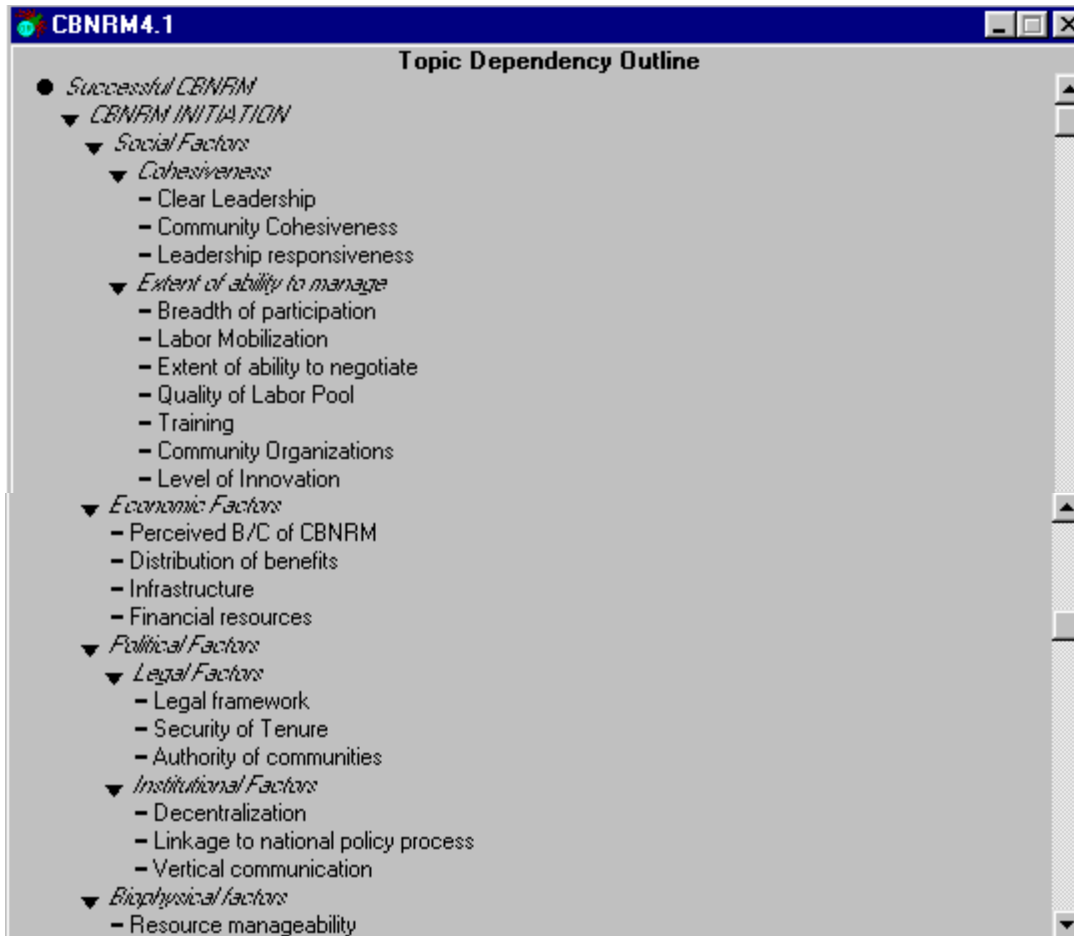
Domain Source:

Citations:

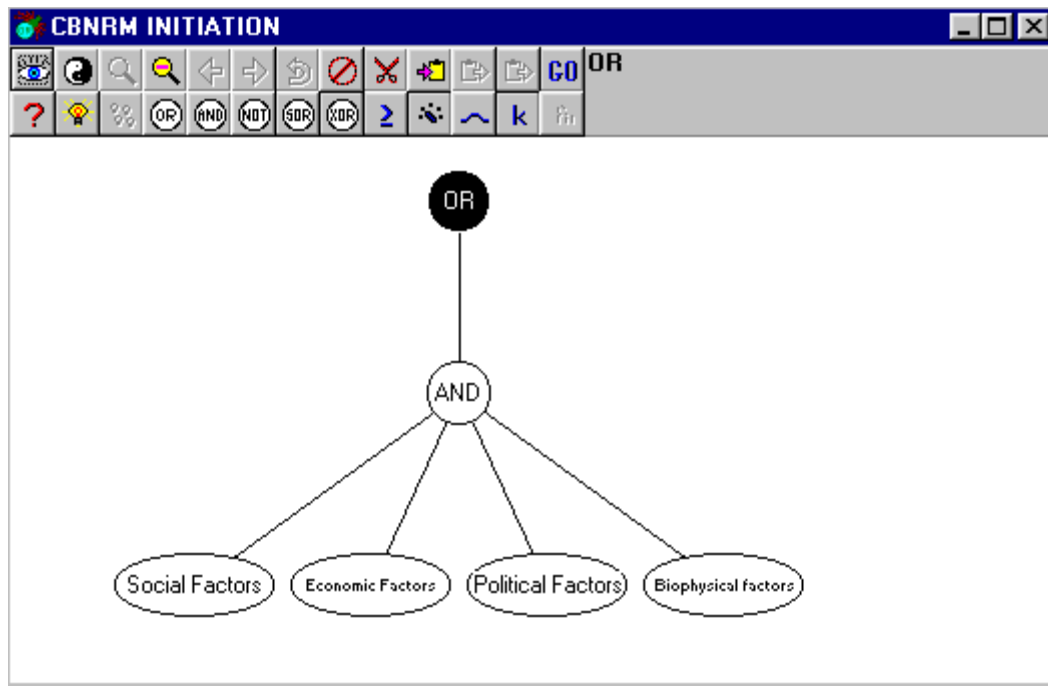
Assumptions:

Weight: 1

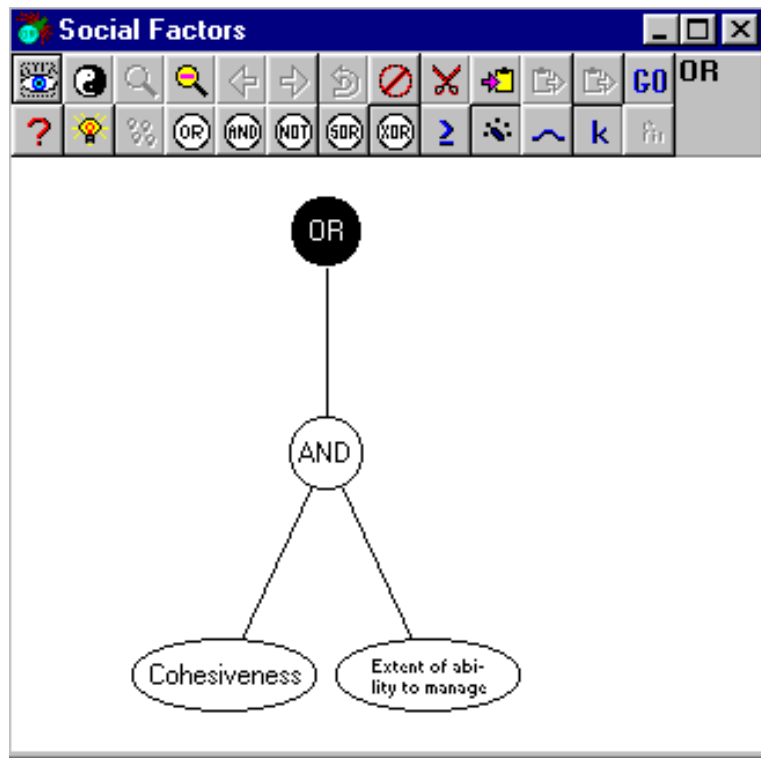
**Figure 4: Fourth NetWeaver™ CBNRM Model Dependency Network:
Revised Model Topic Dependency Outline**



**Figure 4a: Fourth NetWeaver™ CBNRM Model Dependency Network:
CBNRM Initiation**



**Figure 4b: Fourth NetWeaver™ CBNRM Model Dependency Network:
Social Factors Dependency Network**



**Figure 4c: Fourth NetWeaver™ CBNRM Model Dependency Network:
Factors Arrayed in Revised Model Under “Cohesiveness”**

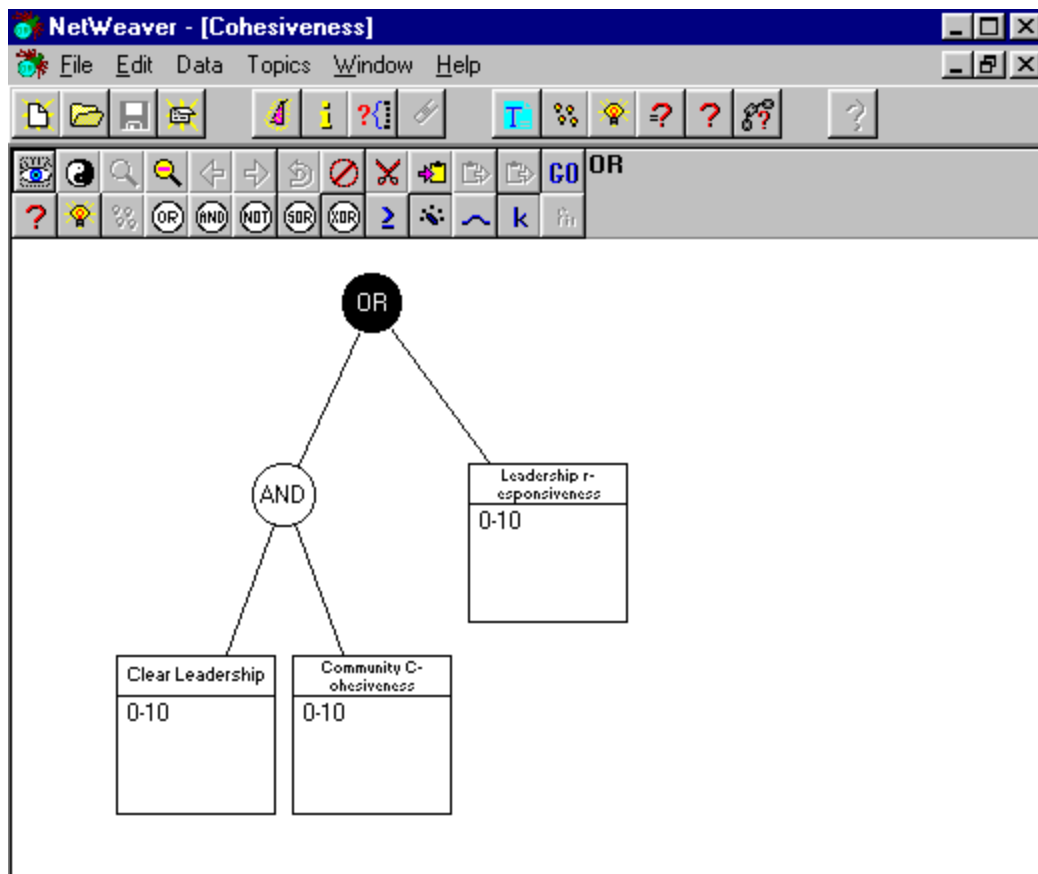
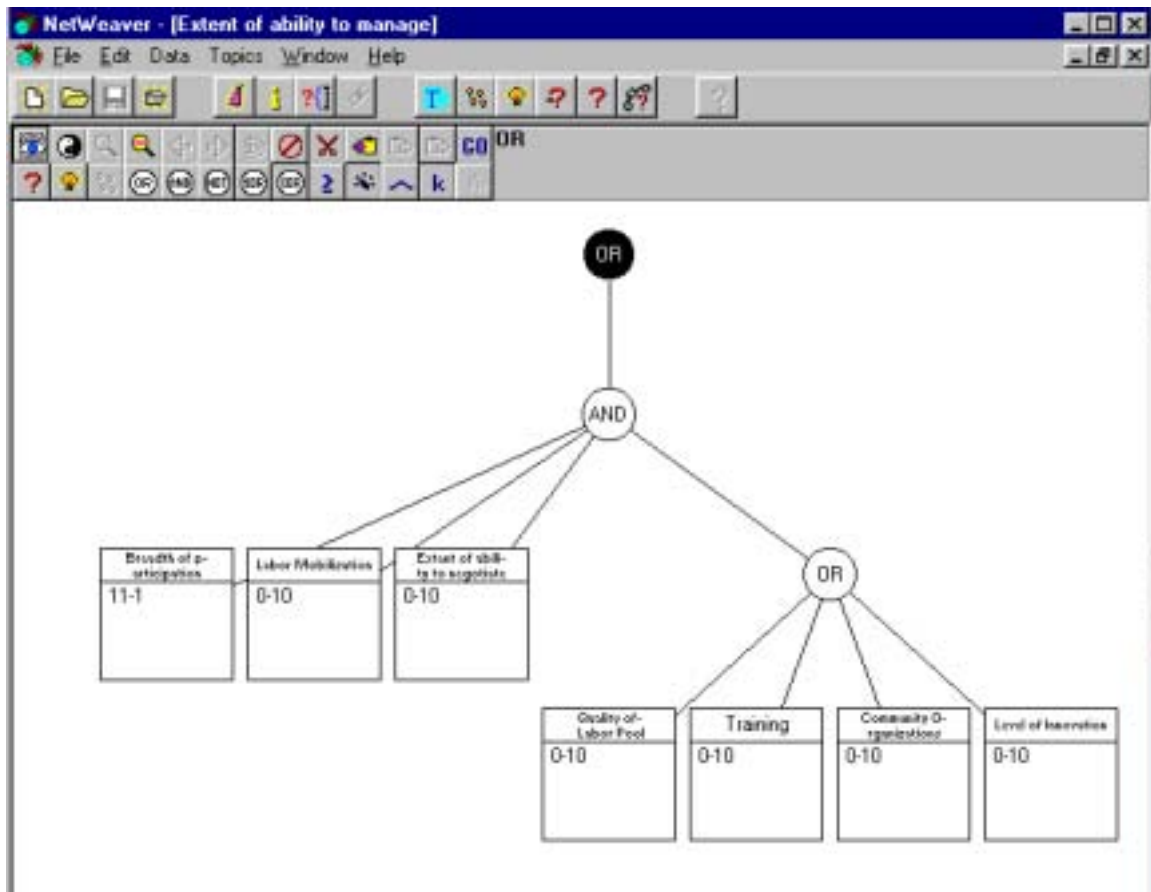
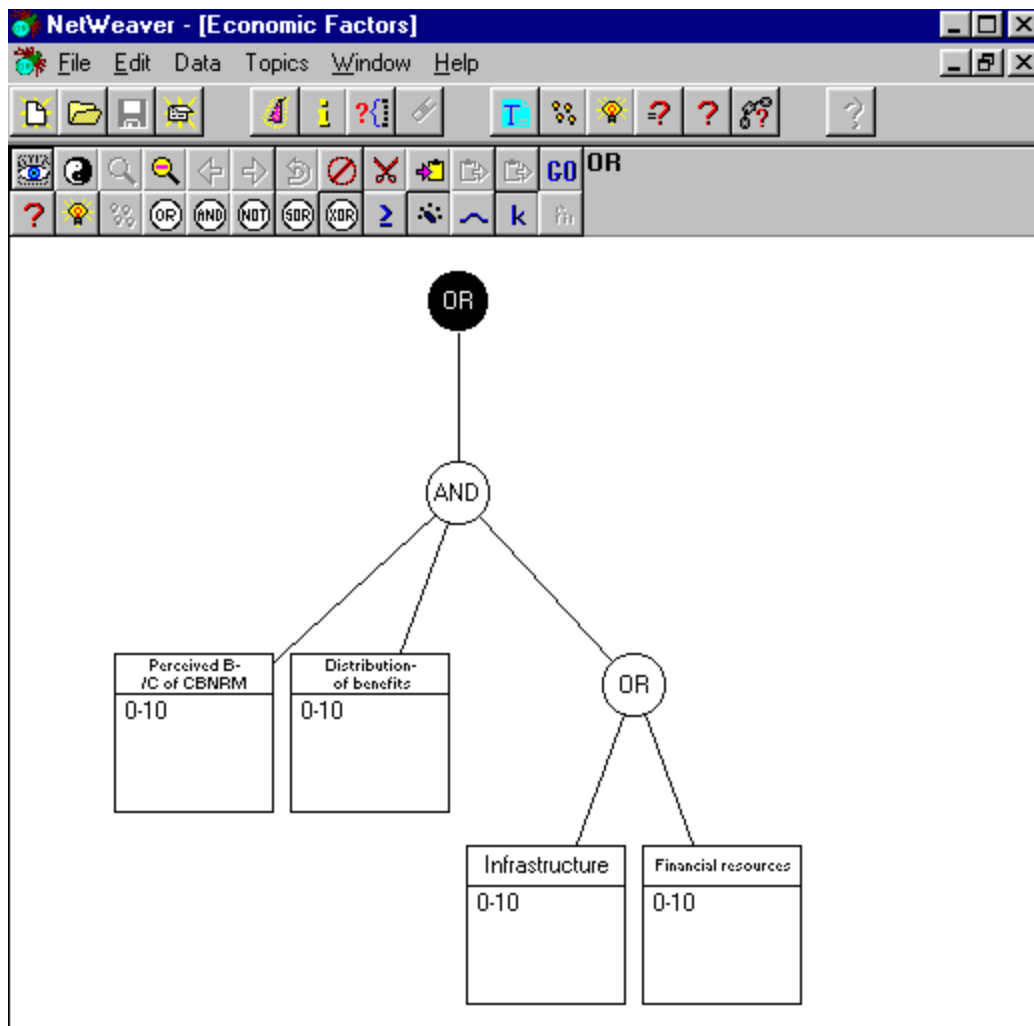


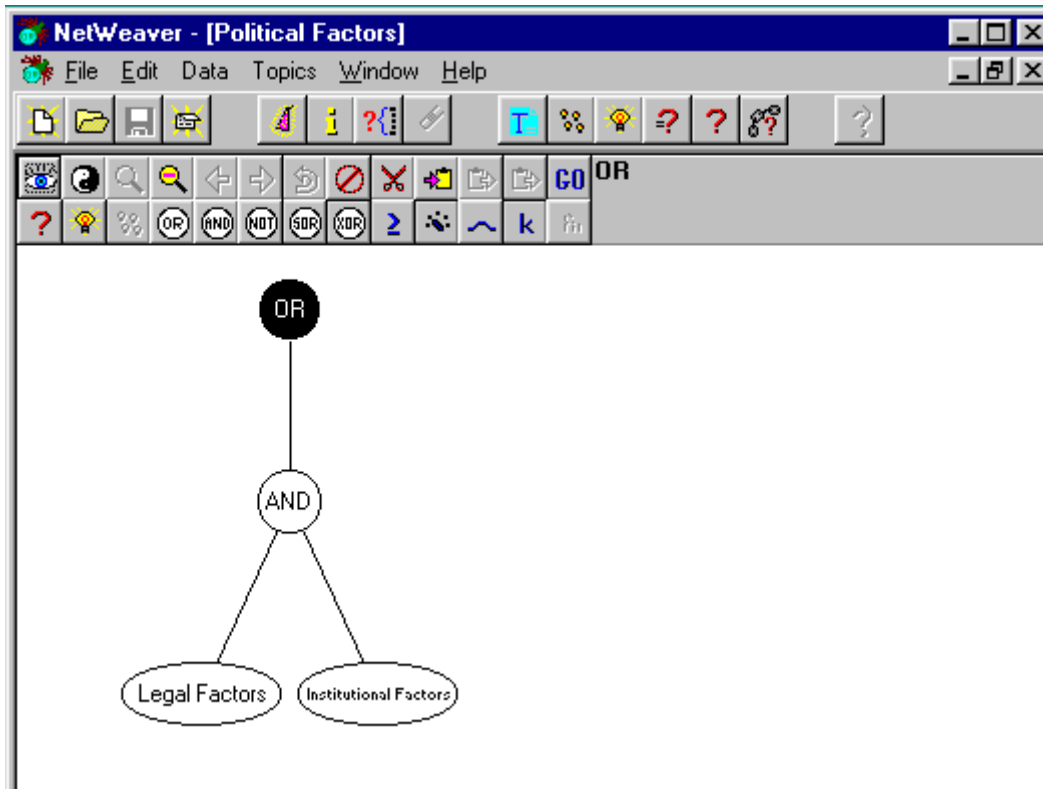
Figure 4d: Fourth NetWeaver™ CBNRM Model Dependency Network Factors Arrayed in Revised Model Under “Extent of Ability to Manage”



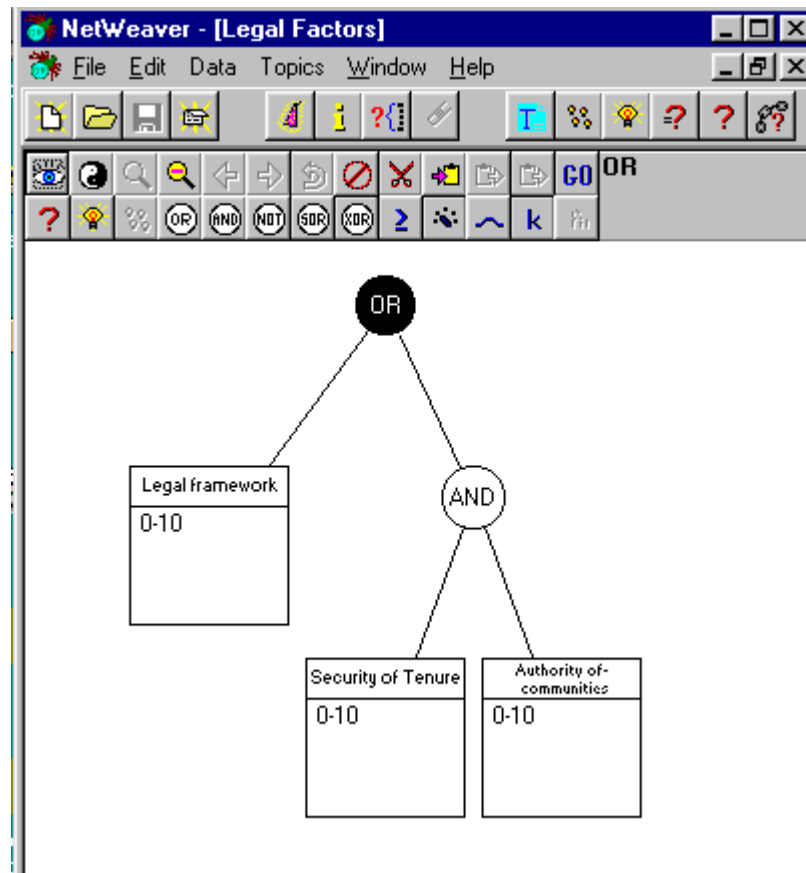
**Figure 4e: Fourth NetWeaver™ CBNRM Model Dependency Network:
Economic Factors Dependency Network**



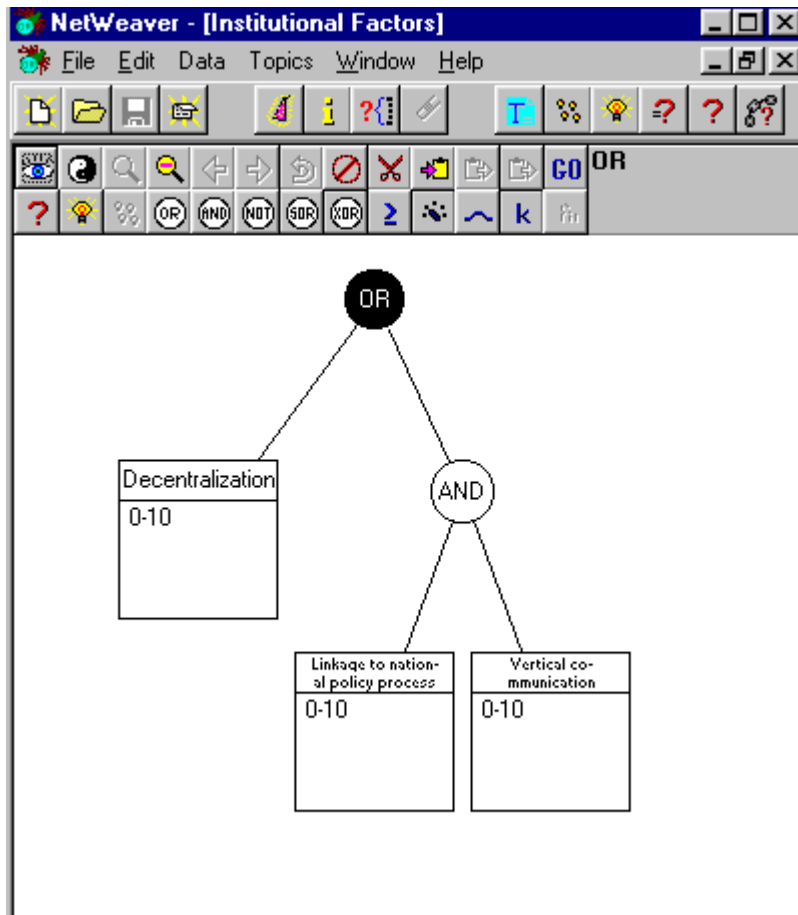
**Figure 4f: Fourth NetWeaver™ CBNRM Model Dependency Network:
Political Factors Dependency Network**



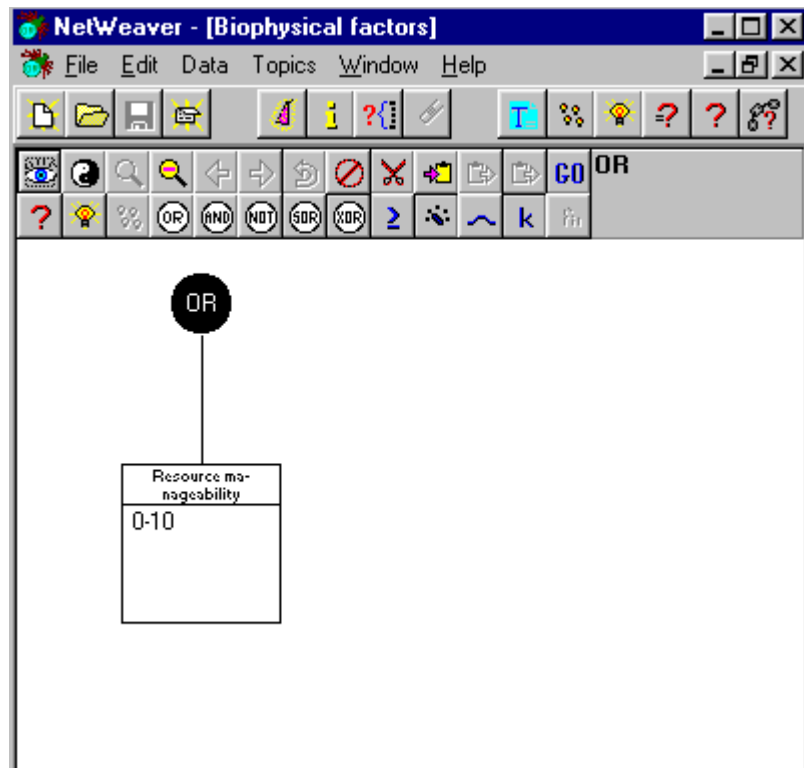
**Figure 4g: Fourth NetWeaver™ CBNRM Model Dependency Network:
Factors Arrayed in Revised Model Under “Legal Factors”**



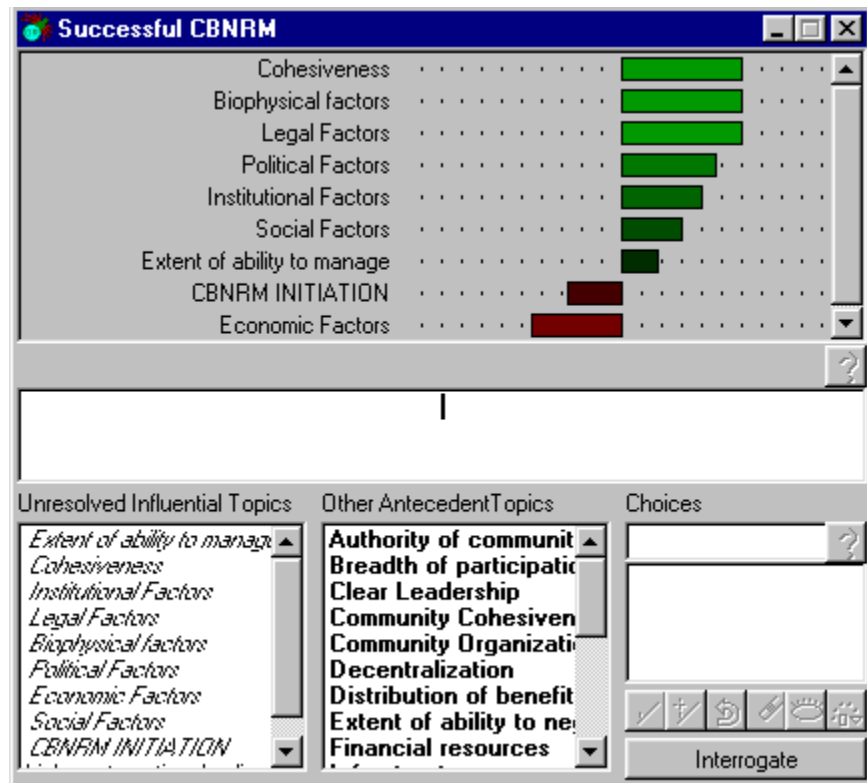
**Figure 4h: Fourth NetWeaver™ CBNRM Model Dependency Network:
Factors Arrayed in Revised Model Under “Institutional Factors”**



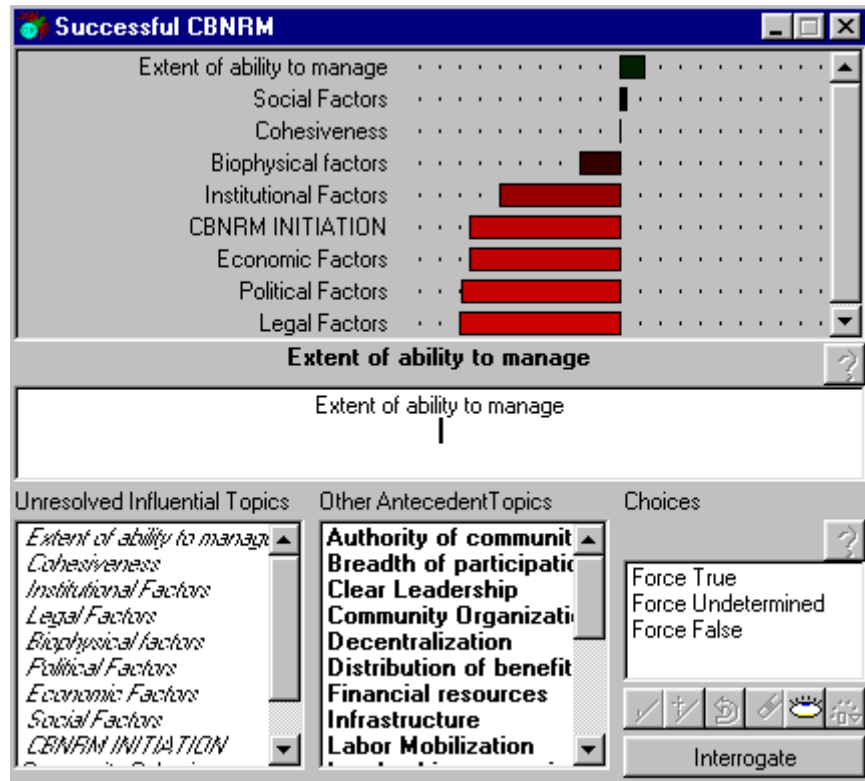
**Figure 4i: Fourth NetWeaver™ CBNRM Model Dependency Network:
Biophysical Factors Dependency Network**



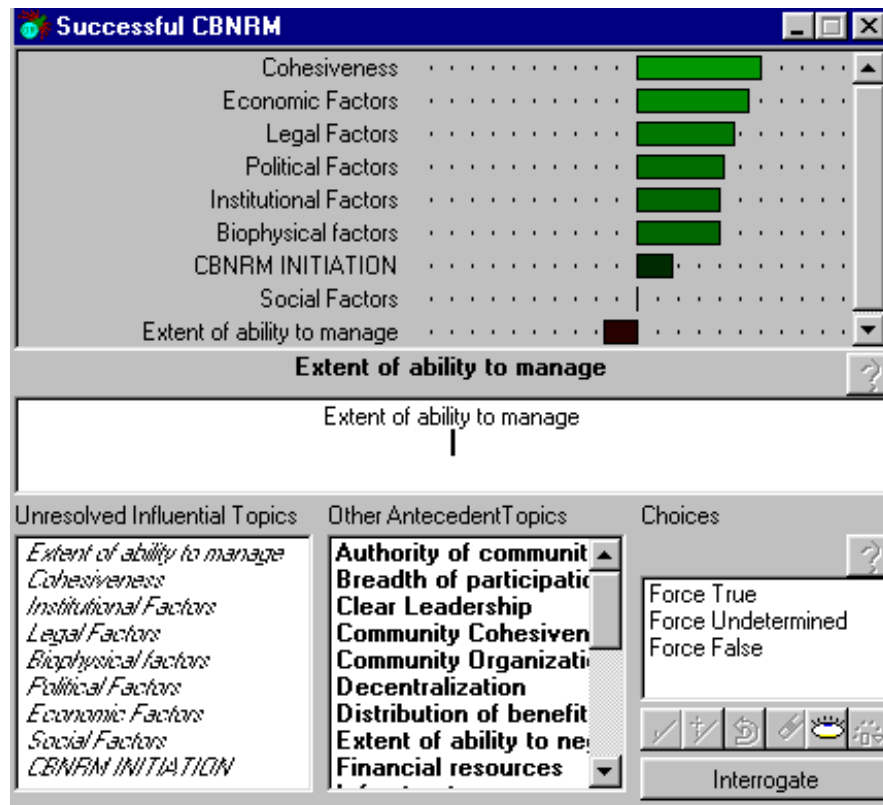
**Figure 5: Products of Fourth NetWeaver™ CBNRM Model:
Results with Data from 13 Sites Batch Processed**



**Figure 5a: Products of Fourth NetWeaver CBNRM Model:
Example of Results with Data Input from Site X**



**Figure 5b: Products of Fourth NetWeaver CBNRM Model:
Example of Results with Data Input from Site Y**



In this case, if we go into the model to Successful CBNRM in the Topic Dependency Outline and then go to the menu for data, then link the data, input the Aliases, Inputs, and Outputs as it requests, we can click on any of the sites and see what the details are such as the ones you see above for Site Y. Going to the Topic Dependency Outline again, if we click once on the dot (●), we can see the key factors for CBNRM INITIATION outlined. Clicking twice on CBNRM INITIATION in the outline next will take us to the dependency network for CBNRM INITIATION. This includes 4 ovals, one respectively for Social, Economic, Political and Biophysical Factors. Because we are looking at the specific dependency network results for Site Y, we see that the Social Factors oval is black; the Economic oval is green; the Political oval is green; the Biophysical is green.

For a deeper look at what the details of Site Y are, we can click on the Eyeball Icon in the menu bar. Once we have done this, we can move around the dependency network for Site Y and obtain additional information. For example, we can move the cursor to the AND node on the dependency network. A pop-up box on the screen (the same information will appear at the bottom left corner of the screen) shows that the overall rating for CBNRM for Site Y is 17.02% TRUE. Looking at the bar on the figure above,

it is possible to see that the bar by CBNRM INITIATION is a very dark green and only slightly to the right of center (about 20% would be a guess, but the 17.02% is the accurate figure). Moving back to the dependency network, we can point the clicker on the Social Factors oval and see that it is .04% FALSE. This explains why the oval here is black (it is FALSE) and explains why in the figure above the bar for Social Factors looks like it is on 0 and therefore is basically indeterminate. We can look at the Economic Factors oval with the clicker and it shows that it is 54% TRUE (see the bright green bar on the figure above); the Political Factors oval as seen with the clicker is 42.4% TRUE; and the Biophysical oval as seen with the clicker is 40% TRUE (again for these, see the green bars in the figure above showing brighter green for both of these).

To look in more depth at some of the ovals, click twice. For example, if we click twice on the Social Factors Oval, we see Cohesiveness showing 60% TRUE, with all factors in this sub-network being by the respondent as 8 on the 1-10 scale. For the Extent of Ability to Manage, we see that it is at 16% FALSE. If we click on the oval, we can go deeper into the model and we find that one of the main problem areas here was Breadth of Participation. More detail on all of the other Social Factors can be obtained in following the path deeper into the networks down to the data boxes in this fashion. For the Economic Factors, we can do the same. Here, we find that the respondent rated Perceived Benefit/Cost of CBNRM at 9 on the scale and is therefore rated in NetWeaver™ at 80% TRUE; Distribution of Benefits at 8 on the scale is 60% TRUE; Infrastructure at 7 on the scale is 70% TRUE; and Financial Resources is 7 on the scale and therefore also 40% TRUE. A double click on Political Factors leads down to two more ovals one for Legal Factors and one for Institutional Factors. Following the same process elaborated above, all the details unfold. Security of Tenure is 60% TRUE; Authority of Communities is 40% TRUE; Decentralization is 40% TRUE; Linkage to National Policies is 20% FALSE; Vertical Communication is 60% TRUE. And, finally, double clicking on Biophysical Factors, we see that Resource Manageability is 40% TRUE.

A description of how these might be interpreted is in the text of the report. This provides a more detailed description of how to move through the NetWeaver™ CBNRM INITIATION Model to look at the linkages and the results of the data inputs.

Annexes D1 and D2

July 27 and September 5, 2000 Versions
of
Questionnaires
for
NetWeaver™ CBNRM Model

Source: **Knowledge Engineering Process Steps: The Proof of Concept of NetWeaver™ as Applied to Community-Based Natural Resource Management** draft report currently being prepared for AFR/SD/ENRM by J. Kathy Parker, Michael C. Saunders, Max W. McFadden, and Bruce J. Miller of The Heron Group, LLC. Annex Material. September 12, 2000.

[NOTE: Questionnaire D1 (July 27, 2000 Version) in this packet was developed through collaborative effort of the Technical Working Group with primary input from Henri Josserand of Associates in Rural Development. Questionnaire D2 (September 5, 2000 Draft Version) reflects changes in array of questions after inputting data from 13 responses to questionnaire D1 by field experts and sensitivity analysis of the data by Knowledge Engineers Saunders, Miller, and McFadden working with Josserand.]

Instructions for Completing the CBNRM Questionnaire

What the Purpose of the Questionnaire is:

The attached questionnaire contains 31 questions that were prepared by and/or reviewed by a number of different individuals like yourself who can be considered as “experts” on CBNRM. The intent in developing the questionnaire was to try and identify individual factors that often play a significant role in determining the successful initiation of a new CBNRM effort in an African country. The 31 questions then are, in reality, the 31 hypothesized factors of success that have been identified at this point in time.

A Request for Your Assistance:

We would like you to read each of the 31 questions in the context of a specific CBNRM project you were involved with. As you do so, ask yourself, **“How important was this particular factor in being able to successfully initiate that project?”** We would then like you to pick a value between 1 and 10 (or, if you prefer, between 10% and 100%) and type the number that represents your evaluation of that factor’s contribution in the box provided.

What We Plan to Do With the Data:

We are asking you to send your data to our Information Technology Specialist Bruce Miller (bjmiller@psu.edu) by August 4, 2000. Upon receipt of your data, Bruce will code it so that it will be anonymous to all but him. We are doing this to protect your data and also to eliminate any potential bias during the analysis phase. Your data and similar data from other respondents will be used only to further develop and refine a new tool that is being developed for eventual field use. As soon as all data have been analyzed, we will send you a complete write-up of the results including how and why the new tool interpreted your data as it did.

What Not to Do:

We do not want you to evaluate the 31 questions or the explanatory statements for content or clarity—only for the question, in bold, given in the second paragraph above. If, when you complete the questionnaire, you want to comment on any of the 31 questions for content or clarity, please do so below the question or on a separate sheet of paper and clearly identify the question you take issue with and why.

Thanks:

We know you are extremely busy so we want you to know that we really appreciate your willingness to take time to respond to our request for assistance.

AFR/SD, ARD, and The Heron Group, LLC

ANNEX D1

Community Based Natural Resource Management Questionnaire

CBNRM Site:

Completed By:

Affiliation:

Date:

Note: The terms 'community' and 'stakeholders' frequently appear below. The range and diversity of CBNRM experiences in Africa are so wide that these terms defy strict and narrow definition. However, for the purposes of this questionnaire, we suggest the following characterizations.

Community: Refers to associations of individuals or groups with close, localized, relationships (neighborhoods, villages, small number of villages).

Stakeholders: Refers to individuals, groups or institutions with a directly related and significant interest in a CBNRM activity. They can include private sector operators, local or central government units, active donors or NGOs.

S0	Social Factors	The following questions address the extent to which social factors played a positive or negative role in the initiation of this CBNRM activity.
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S1	<input type="checkbox"/> Clear Leadership	To what degree was there a consensus on leadership within the community?
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Effective communities tend to have clearly defined leadership. This does not mean that there is necessarily only one leader, but that leaders are clearly identified and broadly accepted as such. A working hypothesis for CBNRM is that the clarity of leadership with respect to access to and use of resources is key. A community may have a clear leader, with strong authority in the area of religion, but this person may not necessarily be the best community leader for resource management. Clear leadership is thought to influence the community's capacity to negotiate with other stakeholders, and to manage NR activities.

S2	<input type="checkbox"/> Community Cohesiveness	To what extent was the community socially cohesive?
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Cohesiveness is assumed to be a critical determinant of success for a CBNRM activity. CBNRM requires that the community members act jointly to identify or consider a CBNRM opportunity, decide to take action, organize themselves and mobilize their efforts to manage the resources and the enterprise, and agree on the sharing and distribution of benefits. This requires both leadership and a certain amount of cohesiveness. For example, if some social or age/gender-specific groups are left out or slighted, chances of significant or long-term success will be slim. Cohesiveness is not synonymous with homogeneity; some communities are ethnically or socially homogeneous but not very cohesive, while others are cohesive in spite of greater social diversity. A community does not have to be very egalitarian to be cohesive, but wide disparities in access to basic resources (e.g. land, water) and in social status are good signs that a community would have difficulty managing a CBNRM activity and sharing its benefits broadly. A good indicator of cohesiveness is whether access to basic education, training and extension services are accessible to members of the community's various ethnic, social, and gender/age specific classes.

- S3 ☐ **Community Organizations** **To what extent did the community have effective, formal organizations?**
- In many cases, central or local governments are unwilling to devolve to a community the authority to manage natural resources and enter into agreements with various parties unless they have some formal, legal status (cooperative, producers' association or economic interest group, conservancy organization, etc.). Formal organization may not, in itself, enhance the community's capacity to manage resources, but it may facilitate relations with other stakeholders. In addition, communities with formal organizations may have more enterprise management skills and experience.
- S4 ☐ **Breadth of participation** **To what extent were some community members prohibited from participating in activities associated with resource management?**
- Another way of asking the question might be: is the intended CBNRM design inclusive of various types of resources and of various resource user groups, including women, youth, elders, within the community?
- S5 ☐ **Extent of ability to negotiate** **To what extent was the community able to negotiate joint resource use and benefits with other communities and stakeholders?**
- This is seen as an important joint determinant of successful CBNRM, although a community's capacity to negotiate applies to various types of interlocutors at several different levels, and may vary between levels.
- S6 ☐ **Labor Mobilization** **To what extent could labor be mobilized at the time it was needed for CBNRM activities?**
- The type of resource being managed strongly determines the type of community labor to be mobilized, but designs sometimes overlook ancillary activities that may involve other types of labor. For instance, women and/or children may be gathering wild forest products while adult males may be mostly occupied by a woodlot or fuelwood activity. Other things being equal, one may also assume that a higher proportion of community labor being mobilized would be consistent with broad rather than narrow distribution of benefits within the community.
- S7 ☐ **Leadership responsiveness** **To what degree was community leadership responsive to the needs of its members?**
- The hypothesis here is that if CBNRM is to benefit most of the community members rather than a small subset of them, the leadership has to be responsive to several constituencies within the community. Responsiveness should broaden the leadership base of support, and facilitate involving various community groups in main and ancillary schemes of CBNRM. The question is, therefore, whether the leadership is responsive at all, and equally responsive to the needs of various community groups (by social strata, gender- or age).
- S8 ☐ **Quality of Labor Pool** **To what extent was this community able to manage a CBNRM activity?**
- The community must be able to manage the labor, technical and managerial requirements of a CBNRM activity. Requirements depend on the nature of the resource, and on the degree of sophistication of resource management methods. However, one would expect that communities that have received training and manage other types of enterprises are more likely to manage a CBNRM activity.

S9 ☐ **Training** **To what extent had relevant community members benefited from training appropriate to CBNRM?**

Other things being equal, one would expect that **appropriate** training is a major factor of likelihood of successful CBNRM. This is especially so if the training has been relevant in terms of the type of resource(s) to be managed by the community, and if it has been available and extended to those community members likely to play a role in CBNRM (i.e. including certain groups often under-represented in training activities, such as women, youths).

PO Political Factors **The following questions address the extent to which political factors played a positive or negative role in the initiation of this CBNRM activity.**

P1 ☐ **Decentralization** **To what degree did a process of decentralization devolve authority from the central to lower levels of government?**

Through the process of decentralization, local governments must have the authority from the central government to establish linkages with local stakeholders, especially if some of the resource management mandate is shifted to, or shared with, local communities.

P2 ☐ **Authority of communities** **To what degree did the government grant to this and to other communities the authority to manage natural resources?**

The rights of communities to manage natural resources, and their responsibilities in doing so, have to be worked out with local and central governments. Although the authority granted to communities is supposed to lie within the bounds of national laws and regulations, these are often inadequate when issues and disputes arise. For instance, effective CBNRM requires that communities responsible for the management of a well-defined set of resources have the capacity to exclude or control resource use by other groups. This authority to exclude others is essential, and has to be sanctioned by a clear agreement, even though this agreement may be somewhat informal or *ad hoc*. Communities must also be able to enforce resource management by their own members, and exclusion of non-members, or stakeholders who are not part of the resource management plan or agreement.

P3 ☐ **Legal framework** **To what extent did CBNRM fall within the legal framework and within acceptable bounds of national policy or tolerance?**

With few exceptions, the legal framework for access to and use of natural resources does not explicitly grant NRM rights or authority to community organizations. This is changing, but slowly. The 'legal framework' in many countries also includes a number of complex and often contradictory legal and legislative instruments governing access to and use of land, forest, wildlife, aquatic and other natural resources. In Africa, legal and legislative frameworks are still very much based on colonial and State-centered visions, so that many CBNRM activities result from an explicit or tacit agreement to 'bend the rules' slightly or to live with practical inconsistencies between what is legal from the viewpoint of the State, and what is legitimate from the traditional perspective of rural communities. Even when there is a willingness to be flexible, there are two further issues. One is the remaining element of arbitrariness on the part of government officials in allowing or preventing CBNRM activities to take place. The other, related issue is that of consistency: why allow it for community A and not for community B, since both fall outside of the strict definition of what is legal? At some point, however, the pressure from communities and from donors to widen the CBNRM experience at the national level induces gradual, incremental changes in the legal and legislative frameworks.

- P4** ☐ **Linkage to national policy** **To what extent could this CBNRM effort be linked to various stages of the national policy process?**
- One of the main conclusions from the review of the literature is that CBNRM experiences do not take place in a vacuum: successful CBNRM activities must be both 'horizontally' and 'vertically' integrated. Horizontal integration refers to relationships established between a community and other communities, local traditional or government authorities, local private sector operators, etc. Vertical integration refers to the linkages between local initiatives, and various elements of the legal, political and policy apparatus at higher levels. These may include provincial and national governments, national environmental action plans and policies, and macroeconomic policies.
- The CBNRM literature also suggests that good vertical linkages between communities and higher national levels must operate in both directions. For example, macroeconomic events and national environmental policies, as well as political processes such as decentralization, represent a 'downward' linkage to community based NRM. Conversely, the social, political, economic and environmental results of aggregated CBNRM experiences at the national level reflect an 'upward' linkage to national processes, often inducing incremental changes in policies and their implementation. The strong vertical linkages necessary for successful CBNRM have also influenced donor and country environmental strategies. For instance, it is not uncommon to see an environmental program focusing mostly on CBNRM to include environmental policy reform, legislative processes, environmental education campaigns, and support to local government units as well. 'Linkages' usually come in the form of institutional relations between communities and higher levels of the governmental and non-governmental authorities.
- P5** ☐ **Risk of Conflict** **To what extent was conflict relevant to CBNRM initiation?**
- Most widespread conflicts stem from fights over control of natural resources: high value, extracted resources such as diamonds, certain ores, oil or natural gas. On a smaller scale, social groups may oppose each other for control over renewable resources: land, pastureland, certain forested areas or water points. Conflicts between *élites* introduce large-scale insecurity and make it difficult or impossible to manage natural resources efficiently. Conflicts among social groups over renewable resources, on the other hand, are a sign that customary systems of communication, negotiation and sharing of resources are breaking down. Under both conditions, the resource use is likely to be increasingly inefficient. However, conflict conditions may also make it much more difficult for CBNRM to succeed at all levels (community, local and central government).
- P6** ☐ **Security of Tenure** **To what degree did perceived security of tenure over resources influence CBNRM?**
- The literature suggests that this is an essential condition. Unless people perceive that they have secure tenure rights over the **entire set** of related resources that they need to manage for their livelihood, they will not invest in their long-term use or sustainability. On the contrary, the 'rational' strategy seems to be to mine the resources as much and as fast as possible before one loses access to them to some other user.
- P7** ☐ **Competition over resources** **To what extent did this community compete with other interests in the planned implementation of CBNRM?**
- Shifting to a CBNRM type of resource management usually implies that the respective roles of, and benefits derived by, various stakeholders are going to change. CBNRM may be more likely to succeed if channels of communication and mechanisms for negotiation and joint resource management are available. However, there are cases where one of the stakeholders perceives the resource as so strategic to its vested interests that incentives to modify the pattern of resource use and to negotiate over the new distributions of benefits are minimal or lacking. For instance, a central government may not want to relinquish (even relative)

control over a resource that is a major source of export earnings. Similarly, private sector or institutional interests may be unwilling to give up control over a resource that is a major input into a complex chain of economic activities.

P8	<input type="checkbox"/> Vertical communication	<p>To what extent did the community's actions inform national authorities on the management of local resources and vice versa?</p> <p>Another major theme in the CBNRM literature is the need for communities to be integrated (vertically and horizontally) with other legitimate stakeholders. As mentioned elsewhere, horizontal integration is about relations at the local level with other communities, traditional authorities, and private sector operators who might be involved in joint ventures. Vertical integration refers to the linkages between CBNRM activities at the local level, and institutional partners at various levels (provincial, central). Such partners include government institutions, NGOs or donor agencies. When communities undertaking CBNRM are well integrated vertically, communications flow in both directions: downwards and upwards. For instance, good vertical integration allows for downward communication between governments and communities on environmental policies, legislation, and technical information. It also allows for upward communication from communities to higher levels on environmental conditions at the local level, to inform policy and decision-making. These are the same channels communities rely on to promote further policy and legislative change, leading not only to greater dissemination of the CBNRM approach, but also to more widespread decentralization of authority (and thus, political power) at lower levels.</p>
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E0	Economic Factors	The following questions address the degree to which economic factors played a positive or negative role in the implementation of this CBNRM activity.
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E1	<input type="checkbox"/> Distribution of Benefits (internal)	<p>To what extent could the benefits of CBNRM be distributed acceptably among the various community members?</p> <p>Successful CBNRM usually requires a sizable investment in time, effort and financial resources on the part of certain members of the community. The community members who are to do the 'heavy lifting' may not do so unless they can expect that a good share of the benefits will accrue to them, as well as to other members of the community. Conversely, there may not be broad support for a CBNRM activity if there is a perception that most or all of the benefits will be entirely captured by a small élite. This is closely related to the question of how the community, as such, decides how to distribute benefits from CBNRM between 'active' and 'non active' members of the community.</p>
E2	<input type="checkbox"/> Sharing Benefits	<p>To what extent did the community share CBNRM benefits with other stakeholders?</p> <p>The distributional issue also concerns non-community or 'outside' stakeholders. These are the groups which have a 'legitimate' claim on some of the benefits from the use of resources. This may be either because they participate in enterprise management (e.g. private sector operators) or because, as a local government agency, they provide relevant technical services. In some cases, the central government considers that taxing benefits derived from the use of national resources is legitimate. The literature clearly suggests that mechanisms must be established for negotiating the sharing of CBNRM benefits within the community and with outside stakeholders.</p>
E3	<input type="checkbox"/> Management Capacity	<p>To what extent could the community manage the benefits from the activity?</p> <p>Most communities have weak management skills. To derive more benefits from better NRM, they may need to: acquire/sharpen their own management capacity, and establish relations with outside operators who can be active partners in resource-based enterprise management. Sometimes it is because these operators have more expertise or better access to processing facilities, or</p>

to markets. Communities also need to determine how much of the activity they should manage on their own, and at what point it is most efficient to turn things over to other partners. Other things being equal, communities with previous experience in managing such activities as grain mills, water pumps, cooperative, etc. are likely to do better than communities which have not had that experience.

E4 ☐ Infrastructure

To what degree did infrastructure enhance the capture of the value of the resources?

Depending on the case, the availability of infrastructure can enhance or reduce benefits from more efficient resource management and use. For example, roads can facilitate access to the resource and to input or product markets. Infrastructure can also take the form of equipment for processing, storage, refrigeration/freezing, or include means of communication, such as access to mail, telephone or fax services, and access to new technologies. There are, however, cases where infrastructure can have a negative impact. Public works do not always allow communities to seek the most efficient pattern of resource use. For example, some communities may find themselves "boxed" in by the patterns of irrigation schemes or livestock water points imposed by outside actors.

E5 ☐ Level of Innovation

To what extent did the community display a capacity to innovate?

The capacity of a community to innovate depends partly on the quality of its labor pool (which may be related to training or information received) and on the capacity of this labor pool to mobilize itself or to be mobilized by the leadership. A community with good capacity to innovate is likely to be better at managing a CBNRM activity than a community that is not so inclined.

E6 ☐ Perceived B/C
ratio of CBNRM

To what extent did community members perceive that CBNRM would bring more to them than it would cost?

One of the strongest recurring themes in the literature on CBNRM is that the perceived value of the resource to be managed must be large enough for the community to go through the considerable efforts of community organization, mobilization, planning, management, and implementation for the activity, plus dialogue and negotiations with a potentially large set of legitimate stakeholders. The perceived value of the resource to the community also has to do with the extent to which the community has access to a market (if the resource is a tradable), to market information, or even to processing facilities. However, the perception of the benefit/cost of doing so is not necessarily straightforward. For instance, communities are often unaware of the potential value of their local resources, once adequately processed, and given good access to markets. Techniques for qualitative improvement are often ignored or discounted because of difficult access to key inputs. The relative benefits and costs also depends on how the community assesses or values the effort by, and benefits to, certain social groups. Some communities tend to have high discount rates (i.e. they would much rather have small benefits now than larger ones in a distant future), while others do not. Finally, the composite assessment of a community's benefits/costs of CBNRM is often at odds with that of other stakeholders or potential partners, making negotiations difficult.

E7 ☐ Financial
Resources

To what extent did access to financial resources constitute a factor in CBNRM initiation?

According to this hypothesis, communities need to have access to a minimum of financial resources to undertake a CBNRM activity. Access can be relatively direct, as when the community can draw on its own (local or migrant) resources. It can also be indirect, as when the community has the skills and knowledge allowing it to secure financial resources from private lenders or through grants.

E8	<input type="checkbox"/> Substitution for Public Investment	To what extent were expected revenues from CBNRM seen as a possible substitute for public investments?
		<p>For communities to go through the effort and trouble of organizing themselves for efficient CBNRM, they must perceive that benefits from the activity represent a net gain. They will not do so if benefits from their work merely are a substitute for investments in public services and infrastructure that they would normally expect the government (or perhaps, donors) to provide. A community may decide to invest in a local school or clinic, but this is seen as a net gain only if the community members are reasonably sure that such an investment would not have been made by the government or some other group.</p>

B0	Biophysical Factors	The following questions address the degree to which biophysical factors played a positive or negative role in the implementation of this CBNRM activity.
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B1	<input type="checkbox"/> Weather Uncertainty	To what extent did weather extremes induce diversification of use of natural resources by the community?
		<p>The relationship between weather uncertainty and degree of CBNRM success is complex. On the one hand, communities living under long-term weather uncertainty have generally developed a number of coping strategies and risk-spreading mechanisms including household economy diversification. On the other hand, the extent to which these practices can facilitate their taking up successful CBNRM activities depends on two things: (a) the extent to which their coping strategies lend themselves to a resource-based application, and (b) the extent to which weather uncertainty allows or rules out opportunities for resource-based community activities.</p>
B2	<input type="checkbox"/> Natural Hazards	To what extent did natural hazards affect the decision to implement a long-term CBNRM activity?
		<p>For instance: "Should local communities be selected for implementing CBNRM projects without taking an in-depth or long-term view of the natural hazards that might impede or even eliminate an otherwise successful project?" In other words, are local communities and potential successful projects placed in jeopardy because project planners and implementers do not assess long-term records on floods, mass land movements (mud slides), earthquakes, volcanic activity, tidal waves, etc. Also, should development proceed without an assessment of randomly occurring natural disasters or should developers insure to the best of their ability that the probability of a natural disaster occurring is practically nil?</p>
B3	<input type="checkbox"/> Resource manageability	From a biophysical point of view, to what extent did the resources lend themselves to management by the community?
		<p>This is the reciprocal of a community's capacity to carry out CBNRM. Because of the type of access or tenure (e.g. common property as opposed to open access resource) certain resources are easier to manage than others. Scale can be a factor (e.g. a large pond rather than a sizable lake, or watershed), the extent to which the resource is mobile (marine fishery, wildlife) can also be important, relative to the size of the community or groups or communities.</p>
B4	<input type="checkbox"/> Resource Use Patterns	At the time of initiation, to what extent were patterns of resource use ecologically sustainable?
		<p>There is obviously no point in trying to establish CBNRM on the basis of patently unsustainable patterns of resource use. In fact, most of the rationale for CBNRM is that the new patterns of tenure and management for the resource will lead to a much more efficient and sustainable mode of resource use.</p>

B5 ☐ **Extent of changes in NRM Practices** **To what extent did the planned change in NRM practice require a significant modification in modes of resource management and use?**

In some cases the shift from the previous pattern of resource use to a more sustainable CBNRM approach is relatively simple. In other cases, the state of resources or other constraints force the community to undertake a major shift in knowledge, practices, mentality and patterns of resource use.

	CBNRM Initiation
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Overall, how successful was the initiation of CBNRM in the site you have described.

Comments:

ANNEX D2

Community Based Natural Resource Management Questionnaire

CBNRM Site:

Completed By:

Affiliation:

Date:

Note: The terms 'community' and 'stakeholders' frequently appear below. The range and diversity of CBNRM experiences in Africa are so wide that these terms defy strict and narrow definition. However, for the purposes of this questionnaire, we suggest the following characterizations.

Community: Refers to associations of individuals or groups with close, localized, relationships (neighborhoods, villages, small number of villages).

Stakeholders: Refers to individuals, groups or institutions with a directly related and significant interest in a CBNRM activity. They can include private sector operators, local or central government units, active donors or NGOs.

S0	Social Factors	The following questions address the extent to which social factors played a positive or negative role in the initiation of this CBNRM activity.
S1	<input type="checkbox"/> Clear Leadership	To what degree is there a consensus in the community as to who is their leader? 1=low 10=high
S2	<input type="checkbox"/> Community Cohesiveness	How socially cohesive is the community? 1 = low, 10 = High
S3	<input type="checkbox"/> Community Organizations	To what extent does the community have effective community based organizations? 1=low 10=high
S4	<input type="checkbox"/> Breadth of participation	Is a significant share of community members prohibited from participating in activities associated with resource management? 1=low 10=high
S5	<input type="checkbox"/> Extent of ability to negotiate	How able is the community to negotiate joint resource use and benefits with other communities and stakeholders? 1 = low, 10 = High
S6	<input type="checkbox"/> Labor Mobilization	The degree to which labor can be mobilized at the time its needed for CBNRM activities? 1=low 10=high
S7	<input type="checkbox"/> Leadership	To what degree is community leadership responsive to the needs of community members? 1=low 10=high

☐ responsiveness

- S8 ☐ **Quality of Labor Pool** Is this community physically able to undertake a CBNRM program? 1=low 10=high
- S9 ☐ **Training** To what extent has the community benefited from training relevant to CBNRM? 1=low 10=high

P0	Political Factors	The following questions address the extent to which political factors played a positive or negative role in the initiation of this CBNRM activity.
P1	<input type="checkbox"/> Decentralization	To what degree has authority devolved from the central government to lower levels of government? 1=low, 10=high
P2	<input type="checkbox"/> Authority of communities	To what degree did the government grant to this and to other communities the authority to manage natural resources? 1=low, 10=high
P3	<input type="checkbox"/> Legal framework	To what extent are community based resource management decisions within the legal framework of accepted bounds of national policy or tolerance? 1 = low, 10 = High
P4	<input type="checkbox"/> Linkage to national policy process	To what extent can the CBNRM effort be linked to various stages of the national policy process? 1 = low, 10 = High
P6	<input type="checkbox"/> Security of Tenure	To what degree do people perceive tenure security in making natural resource management investment decisions? 1=low, 10=high
P8	<input type="checkbox"/> Vertical communication	To what extent do the community's decisions inform national authorities about the management of local resources and vice versa? 1 = low, 10 = High
E0	Economic Factors	The following questions address the degree to which economic factors played a positive or negative role in the implementation of this CBNRM activity.
E1	<input type="checkbox"/> Distribution of Benefits	To what extent can the benefits of CBNRM be distributed acceptably among the various stakeholders? 1 = low, 10 = High
E4	<input type="checkbox"/> Infrastructure	To what degree does the infrastructure enhance the capture of the value of the resources? 1=low 10=high

- E5 ☐ **Level of Innovation** To what extent do local communities display a capability and a willingness to innovate? 1 = low, 10 = High
- E6 ☐ **Perceived B/C ratio of CBNRM** To what extent do community members perceive that CBNRM will bring more to them than it costs? 1=low 10=high
- E7 ☐ **Financial Resources** To what extent do access to financial resources constitute a factor in CBNRM initiation? 1=low 10=high

B0 **Biophysical Factors** The following questions address the degree to which biophysical factors played a positive or negative role in the implementation of this CBNRM activity.

B3 ☐ **Resource manageability** What is the extent to which the resource(s) lends itself to management by the community? 1 = low, 10 = High

	CBNRM Initiation	Overall, how successful was the initiation of CBNRM in the site you have described.
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Comments:
